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PALLIATIVE RADIOTHERAPY OF MALIGNANT GROWTHS[1]

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THE last few years have witnessed a remarkable change in attitude toward the problem of cancer therapy. The statistical study of the disease, with more careful death records and more autopsies, has shown that there has been in most countries like our own with defective death certificates, a large amount of unrecognized cancer. The statisticians feel that with the discovery of all this material, the cancer death rate will rise to something like 125 per 100,000, instead of the 95 per 100,000 which is now the official figure for the cancer rate in the United States. The propaganda of the American Society for the Control of Cancer has led to a demand from the public for more efficient therapy than the medical profession has been prepared to give, while studies of the records of hospitals have shown the relative inefficiency of cancer treatment when all types are included, only some 20 per cent of patients admitted to the hospitals being operable. Then the utterly unsupported claims for cures which followed the development shortly after the War of high voltage X-ray apparatus caused the surgeons to study their own material with much more care, the results being a sudden sobering of the operative claims when cases were followed for periods of five years and more. Time has shown that neither the exaggerated statements of the earlier roentgenologists were true, nor could the surgical statistics of twenty years ago be regarded as in any way representing the real results when patients were properly followed. What has arisen from the situation is, of course, the fact that surgery is still effective in certain groups of tumors and also that carcinoma of the cervix, especially the borderline groups, can be better treated by radiation than by surgery. The sobering attitude of all these facts is reflected in the changed attitude of the whole profession toward the actual cure of cancer, and the word "arrest" is now being used by those who try to make their language fit the facts. In some ways the surgical pessimism has gone a little too far, for a study of the material has revealed the disheartening fact that a patient cured of one tumor is perfectly capable of developing another one later,—a matter which should have been expected from the multiple occurrence of tumors in the same individual. In fact, recent studies have shown that this multiple occurrence is just what would be expected statistically from the frequency of cancer in the general population, that is, a certain number of patients might well develop two tumors, either simultaneously or within a short time of each other. It is, therefore, nothing astonishing that a woman cured of a carcinoma of the cervix may a few years later develop a carcinoma of the breast. Fortunately these double carcinomas are relatively rare.

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In the past, both surgeon and radiologist confined their attention to what they called "cures." The surgeon in such statements was on much sounder ground, for in a certain proportion of accessible malignancies he really did produce a cure. In my own records, and those of many other institutions, there are, for example, many cases of carcinoma of the breast which can be considered as cured in the true sense of the word, that is, they have gone eight to ten years without any evidence of return. True, recurrences have been seen after fifteen years or more in the regional nodes, lungs, or bones, but again, these are very infrequent. Only in carcinoma of the cervix and the skin are there any such long-time records of real cures from radiation. But if only 20 per cent of the hospital material is operable, what shall be done with the remaining 80 per cent? Many of these are entirely beyond any therapy. The results of radiation treatment of carcinoma of the lung, of the stomach, of the liver, pancreas, kidneys, prostate, and esophagus have in general been an utter failure when regarded from the point of view of permanent results, and in most of these sites—even from the palliative aspect, with but rare exceptions—nothing has been obtained. The operative achievements on carcinoma of the stomach, even in those cases which were considered operable, have been small. Carcinoma of the rectum has been somewhat more favorable in its surgical aspect because of the possibility of removing the gut completely and also because of the rather low grade malignancy from the surgical point of view of many of the neoplasms which attack this viscus. The same is true of certain other localities, when the patients come in the early stages for treatment. On the other hand, radiologically the rectum and sigmoid have been two of the least satisfactory, for the slow-growing mucus-forming tumors of this region, which are the most common type and metastasize late, and are therefore favorable to surgery, have been so resistant to radiation that little palliation has been obtained.

Thus successful radiation implies an additional requirement not implicit for the surgical cure of a growth, that the neoplasm is radiosensitive. In some instances this is closely correlated with microscopic morphology, but one often meets with exceptions.

In the attempt to achieve the impossible by both surgery and radiation, extensive operative procedures, with a high resulting mortality, have been tried, but are now being abandoned. In the past, excessive radiation dosage, with serious damage to the patient's general health, has not been infrequent. But gradually the attempt to cure the incurable has been abandoned by both parties and a saner view prevails.

The destructive dose for tumors varies in man between 700 r-units and 7,000 r-units or more. The average is probably close to that of the transplanted animal tumors, which requires between 2,500 and 3,500 r-units for a complete destruction of all the cells. It is evident that human tumors of the higher degrees of radioresistance must be treated not only with external radiation through the skin, but an additional dose must be added by interstitial radiation with filtered radium, either element or emanation. Here the accessibility of the tumor to be treated plays as important a part as it does in surgical operability. Just as at least 80 per cent of those who apply for treatment for malignant tumors are already in an inoperable stage, so at least the same proportion are not in a condition suitable for the application of radiation for a cure.

If the patient is inoperable from the point of view of cure, and nothing can be promised from the radiation side, what may be done to prolong life within the limits of comfort or of ability to work? That is the point concerning which I wish to speak. Frankly confessing our inability to cure a certain group of tumors by any method, how far can we go with surgery, with radiation,

or with the combination of the two to prolong life in comfort? To be effective, such surgery must not be dangerous to the life of the patient, and the radiation must not be so heavy as to render the patients so miserable that they cannot go about their daily duties for a time. It is difficult to evaluate the results in statistical terms, for there is as yet but little accurate information on the length of life of the untreated patients, and nowadays there are relatively few patients who are never treated in some fashion. I have elsewhere made an appeal for the compulsory notification of all cases of cancer as soon as diagnosed, with the hope that the material so obtained might be used to give us further information on this important point, for it is easily seen that the mere collection of a series of patients with carcinoma of the rectum, for example, adding up the years and months that they survive, and dividing by the total, gives us no practical information. Unless it is possible to add to the crude survival periods some information concerning the histological types of tumor, their sites and distribution, the figures will be of but little value. Thus I have seen a patient with carcinoma of the rectum live seven years with a simple colostomy, but how many tables exist of a large series of patients treated with simple colostomy, with the microscopic examination of the tumor to correlate, if possible, the length of life with the histology? Until this is done we have no firm basis for assuming that radiation or surgery really does prolong life. All we can do is to study the individual and judge from his clinical course whether or not our therapeutic measures have been useful. And it must be frankly confessed that in not a small number of instances our best therapy fails to check the course of the disease, and the only thing which we can claim is that the patient's mental condition has been improved.

Take, for instance, the advanced, ulcerated carcinoma of the breast. What is the right thing to do for these unfortunate patients? Surgery offers no cure; neither does radiation. The nodes and thoracic wall are involved; mediastinal and bone invasion is probable. Nevertheless, in my own experience I have felt that the removal of the breast and as much skin as is possible without recourse to grafting, leaving the nodes in the axillary and supraclavicular regions undisturbed, does help these patients. With our present operative technic the mortality is extremely low. The anesthesia is not dangerous; the operation can be done in a relatively short time, and the patient can leave the hospital in ten days or two weeks. The mental horror which accompanies these huge ulcerating masses is relieved. The patient no longer is an offense from the odor which follows the invasion of putrefactive organisms into the necrotic material. Dressings are no longer needed, and the patient is relieved of that expense. As soon as the wound is healed post-operative radiation with moderate voltages should be given over the nodes of the neck, the axilla, and the entire skin surface in which invasion may be expected. If the patient begins to cough, high voltage doses should be directed to the mediastinum. X-ray films will often reveal nodules in the chest to which attention can be directly paid during the course of the radiation. The cough, of course, is due to the pressure on the bronchi and trachea, with consequent narrowing of the lumen, retention of secretion, or irritation from invasion of the bronchial wall. Many of these patients can have their cough relieved for considerable periods. The accumulation of pleural exudate also is checked. If the bones are involved, they can be radiated, with the relief of pain. In most patients of this type no local skin recurrence will follow if sufficient radiation is given. This means treating these persons every week or two for some time over the suspected areas. In my own material a number of these patients have been able to go back to work and be fairly comfortable for varying periods of from six

months to four years. If the tumor metastasizes in the bone it usually does not seem to involve the lung, and the reverse is true. The bone cases are the most suitable for the prolongation of life. They can be rendered very comfortable by moderate radiation, whereas the lung cases as a rule go rapidly, but if sufficient radiation is given, the cough can be kept down, as has already been said, and when the fatal termination comes, it is usually rapid. They often develop a low grade pneumonia and die in a few days. A number of my patients with bone involvement have developed cerebral metastases, with death in a very short period, though they have been perfectly comfortable up to the occurrence of this accident.



Fig. 1. Lesion found March 17, 1925, showing extensive erosion of the pelvic bones.

The following is an example of such palliation. The patient, a woman of 48, came to my clinic on crutches on February 1, 1925. She had had an amputation of the breast in May, 1924. The growth was evidently a fairly extensive one, and the evidence is pretty clear that she had early bone involvement, because she noticed a pain in the right femur January 7, 1925, and X-ray films (Fig. 1) taken at that time showed extensive metastases into the right femur and ilium. Radiation was immediately begun over the pelvis, 160 K.V., 0.5 mm. zinc plus 1 mm. aluminum filters, 40 cm. distance, giving about 80 per cent of an erythema. The treatments were given, as usual, about two weeks apart. She had no improvement for two months, but on March 30 she reported that she had no pain, and that she could lie on the right side. Crutches were abandoned, and she was taking no sedative medicine. She was doing her housework, and was gaining weight. In 1928 she complained of pain in the right shoulder, and X-ray examination showed involvement of the scapula, clavicle, and the upper end of the humerus on the left side (Fig. 3), and there was some evidence of involvement of the ribs on the right. Radiation of these areas checked

her pain. On May 1, 1928, she fell and broke her radius, which healed promptly. There was no evidence that this was a pathologic fracture. From time to time the pelvic condition was radiated, and there seemed to be a certain amount of ossification taking place in the old areas, which were almost free of bone, as the cuts will show (Fig. 2). During 1928 she was radiated chiefly to the shoulder—the pelvis and the hip gave her no pain. On May 11 she came in and reported that she had a little pain in the right ear, but otherwise was very well. She died suddenly on June 6, 1928, with a cerebral involvement, having been sick only a few days.



Fig. 2. Roentgenogram made February 17, 1927, showing repair in bones of the pelvis. Same case as shown in Figure 1.

This was a case of a woman palliated for over three years. Her condition was so bad that she was walking on crutches and taking a considerable amount of narcotics. After a few radiation exposures she was able to go back to her work and live in fair comfort, gaining weight, and feeling well for three years and four months, when she died suddenly from a cerebral lesion. My records show a number of similar palliations, some longer, some shorter, including one with a moderate paraplegia who for a year after treatment was able to walk without support.

Another example of prolonged palliation is a case of carcinoma of the breast. This woman was admitted to my clinic on July 21, 1925, the referring surgeon saying that she had an extensive carcinoma, with much involvement of the axillary nodes, and that she should have heavy radiation, if possible. Treatment was begun with our usual technic of about 75 to 80 per cent of an erythema dose, at 160 K.V., 0.5 mm. zinc and 1 mm. aluminum filters. During 1926 the patient was very well and gained in weight. In July, 1927, she was reported as all right, and had



Fig. 3. The shoulder lesion on February 2, 1928. Same case as shown in Figures 1 and 2.

gained several pounds. In 1928 she began to cough, but there was no radiological evidence of recurrence. Shortly after this she was told by a physician that she had a carcinoma involving the entire lung. An X-ray film taken on February 3, 1930, showed that the patient's lung condition had greatly improved since the radiographs of September, 1929, and films taken on September 16, 1930, again reported some improvement in the lung condition. Despite the lung involvement in 1929 the patient gained weight under renewed radiation, and reported on January 3 that she had gained 12 pounds in the last three or four months. She was, however, short of breath. Radiation was changed from the lower voltage to 200 K.V., 8 ma., 50 cm. distance, and 60 minutes exposure with 0.5 mm. copper and 1 mm. aluminum filters. This is about 600 r-units. Under this treatment she continued to improve. At her last appearance, November 11, 1930, she was so short of breath that she was advised not to take any more treatments.

This is a record of an extremely advanced, hopeless case of carcinoma which survived in fair comfort a little less than five years.

An example of an unexpected palliation of a sarcoma of the pelvis follows. The patient was a woman 43 years of age, who had had pain in her left hip for several months. On examination there was found to be a large palpable mass which involved the inner surface of the left ilium. The iliac muscle was pushed up over the tumor. Radiographs showed no attachment to the bone. Biopsy revealed a tumor composed of small cells with no bone formation. She came under my care on March 31, 1925. After two exposures the patient reported her pain was much diminished. She was radiated fifteen times during 1925, the doses being about 80 per cent of an erythema, 160 K.V., 0.5 mm. zinc and 1 mm. aluminum, 40 cm. distance, and 8 milliamperes. During 1926 she received thirteen treatments; in 1927, eight treatments, and in 1928, seven treatments. On March 25, 1929, the patient said that she had never felt so well. During all this period she had been at work, and had gained 22 pounds in 1926. In December, 1927, she was examined by the surgeon in whose care she had originally been, and he reported that she was in fine condition. The patient was last seen by me on May 21, 1929, when she repeated the above statement about feeling so well. She was told to come back in the Autumn, but failed to keep her appointment. On inquiry by a social service nurse it was found that she had died very suddenly on June 29, whereas on May 21 she had felt extremely well. No explanation could be obtained for this death. It might have been a cerebral metastasis or any one of the complications which may occur in conjunction with malignant growths, but there was certainly no local return.

An example of prolonged palliation in a case of carcinoma of the breast is the fol-

lowing. A woman 48 years of age was referred to me for treatment for a large fibromyoma of the uterus reaching the fundus. As she had high blood pressure and headache, it was thought wiser not to operate on her. She received eight X-ray treatments, at 160 K.V., with 0.5 mm. zinc and 1 mm. aluminum, 40 cm. distance, 8 ma., and 15 to 20 minutes. This checked her periods; the myoma shrank down, and her pressure symptoms were entirely relieved. About the time this treatment was finished, some two months after she came to me, she called attention to her breast, and I found that she had a carcinoma with axillary nodes. She was operated on promptly. She developed a recurrence in the pectoral region, above the level of the axilla, six months later, and when seen by her surgeon, he regarded her as inoperable. There were also some enlarged nodes in the supraclavicular region. A roentgenogram at this time showed there were no definite areas of infiltration in the lung, but evidence of considerable pleural thickening at the site of the swelling. At this time she consulted Dr. Burton Lee of the Memorial Hospital, in New York, who advised the radium pack, insertion of gold needles in the nodule in the anterior axillary region, and treatment of the mass in the other axilla by the insertion of platinum needles. This the patient refused, preferring to take X-ray treatment. Exposures were then given of the same type as mentioned above, but somewhat heavier, reaching about 90 per cent of an erythema dose—at one time she did receive an erythema. These were repeated about every two weeks with intervals of rest, and in 1926, a year after the first operation, she had marked edema, with distinct nodes above the left clavicle, and the left arm began to swell. Radiation was continued, and in June, 1927, I had a note saying that she was in fine condition. There was some slight swelling of the left arm; the mass in the pectoral region had disappeared, as well as the nodes. The nodes above the clavicle were not palpable. The mass in the right axilla had disappeared entirely under radiation of that region. Following January 21, 1928, that is, three years after her operation, she showed no evidence of carcinoma. On November 20, 1930, she had no evidence of any trouble except the swelling of the left arm, with a good deal of puffiness above the left clavicle. The nodes in that region could not be definitely made out. There was nothing to feel in the right axilla.

Here is a patient who was seen by three surgeons, all of whom believed she had a recurrence, and yet that recurrence disappeared under radiation of a very moderate voltage and quantity, and the patient was apparently in perfect health five years after her operation.

A highly sensitive tumor may disappear with very little radiation. A patient, male, 34 years of age, was referred to me by a surgeon on account of a very large abdominal tumor, the size of a pregnancy about the eighth month. The patient reported that his left breast had been very much swollen a year before, but under local treatment this swelling disappeared in two weeks. After this he noticed the abdominal tumor. At the time of examination this tumor filled the whole abdomen, was smooth, elastic, and not very firm. On physical examination the left testicle was found to be missing, and the patient stated that the tumor had begun on the left side. The man was rather pale, but otherwise nothing was found on physical examination. Biopsy was refused, but the growth was probably a seminoma. The patient received three heavy doses of X-ray, one on the right side of the abdomen, one on the left, and one on the left hip. These were just sub-erythemas. Two were given at 160 K.V., with 0.5 mm. zinc and 1 mm. aluminum filters, and one at 200 K.V., with 0.5 mm. copper and 1 mm. aluminum filters. Within a short time after these treatments, the tumor disappeared. A month after the

man was first seen he had gained three pounds; two months later he had gained six and a half pounds more. After this, at monthly intervals, the patient received moderate doses of X-ray at 190 K.V., with 0.5 mm. copper filter. The doses were about 80 per cent of an erythema, and were given with the idea of preventing the possible return of the tumor. We heard from him last on February 24, 1930, that is, five years after his first treatment, and he reported that he was in perfect health. The value of the report suffers from the fact that no biopsy was done, as the tumor was so large that the competent surgeon who saw him first thought he was not justified in doing a laparotomy merely to get a specimen. Presumably the growth was a seminoma of the testicle, which is known to be highly sensitive to radiation. The point is that at no time was this man given extremely heavy doses, except the first three treatments, after which the tumor disappeared.

Another interesting case is that of a female child 21 months old. The patient was explored in December, 1924, because of an enormous tumor which filled the whole abdomen. The tumor was found to be inoperable, and unfortunately the surgeon took no biopsy, considering the child's condition to be too desperate to take any risks of prolonging the operation. The growth was probably a neuroblastoma, as such growths are sensitive. At this time there was moderate paraplegia, apparently due to pressure from the tumor. Radiation was begun, about 300 r-units, at 200 K.V., with 0.5 mm. copper and 1 mm. aluminum, on January 13, 1925, and repeated at intervals of about two weeks. The child began to show distinct improvement five months after the first radiation. For three months no treatment was given, and then it was begun again and carried on at about monthly intervals, the doses being about 400 r-units. During the following year fourteen treatments were given. The year after that, eight; the next year, six; the next year, only three, and this year, only two. A year after the treatment was begun the child was much better, and the tumor was smaller. Eight months later she was reported as very well. Nine months later the tumor mass began to grow, and radiation was given more frequently. On May 22, 1928, that is, two years and four months after the treatment was begun, there is a note that the child was in fair condition and the mass smaller than at first. On November 26, 1928, the records say the child was in good shape, the mass was smaller, and the condition excellent. On February 18, 1930, came a note saying the child was in good condition. I saw her on November 18, 1930. No tumor mass was palpable. The child looks like a normal child of six years of age, bright and intelligent. Incidentally, she walks perfectly at the present time.

Another example of palliation in a radiosensitive tumor was a male 46 years of age, who had a large retroperitoneal lymphosarcoma, the diagnosis having been made by biopsy. He was referred to me on October 13, 1925. Treatment was begun with moderate voltage X-ray, about 160 K.V., 0.5 mm. zinc and 1 mm. aluminum, giving about 400 r-units per dose, and using various portals to radiate the large mass in the abdomen. The treatments were given at about two-week intervals at first, and then less frequently. In 1927 he received only five treatments, and in 1928 only two. In 1929 he was examined by the surgeon who referred him to me, and was found to have no evidence of any trouble. On September 25, 1930, that is, about five years after his first treatment, he reported that he had been entirely well until about three weeks before, when he had become short of breath and weak. Examination showed the spleen to be very much enlarged, but there were no other nodules. The patient is still under treatment, but it is evident that return of the growth has begun. Nevertheless, here is

a five-year palliation with moderate X-ray dosage.

I feel very strongly from the study of individual patients, though I cannot demonstrate from a large amount of material, that this technic of handling advanced and hopeless mammary carcinoma, even though it does not necessarily prolong life, brings a great deal of comfort to the patient. How difficult it is to judge these matters is well illustrated by the treatment of myelogenous leukemia. A number of writers have stated that radiation does not prolong the average life of these patients. Nevertheless, I have a number of patients with leukemia, who, when I first saw them, were moribund, either because they had been treated improperly or because a diagnosis had never been made. Some of these patients had a hemorrhagic condition with large nodules in the skin and an enormous number of leukocytes—sometimes up to a million, with great destruction of the red cells. In a month or two they were back at work, the spleen reduced to almost normal dimensions, the hemorrhagic diathesis stopped, and they have remained in this condition for three or four years. Now certainly these patients would have died within a few weeks if not treated, so that I cannot agree with those who say that life is not prolonged. It may be that in a large series no great average prolongation of life is observed, but the individual case may show a remarkable capacity to come back. The physician does not refuse to treat cardiac and nephritic patients, even though he cannot cure the lesion. The main thing is to get the patients adapted to the physical limitations which the disease imposes on them and make them useful within these limits, even though the lesion may remain unchanged so far as anatomical conditions go.

In addition to the purely scientific aspect of all this material, the economic question of radiation plays a fairly important part. Inasmuch as the average income of a citizen of the United States is somewhat under $2,000 a year, it is obvious that the average cancer patient cannot afford high-priced treatments, so we must make every effort to render such radiation reasonable in price. This implies a large amount of material, handled in an efficient and business-like way, so as to reduce overhead costs as much as possible. From the cases cited you will see that many of them have been treated with low voltages, not above 160 kilovolts. Under these conditions even the inefficient X-ray tubes which we now possess for therapeutic purposes last six months or more if used eight hours a day. The tube cost per patient is therefore low. Experimental tubes have been made which have four or five times this life, and the Radiological Society should make every effort to see that these tubes come on the market as quickly as possible.

On the other hand, there is a certain amount of physical and clinical evidence which points to the necessity for a change in the type of our radiation if the best results are to be obtained. The biological experiments which Regaud made many years ago have not excited very much interest in this country. These furnished the demonstration that sterilization doses, using the testicle as biological material, are most efficient when they are given as a divided dose on successive days rather than as the single huge exposure originally recommended by German workers. In addition, Regaud showed that the use of highly filtered X-ray given for long periods was more effective than shorter doses. The combination of these principles is seen in the current practice at the Curie Institute, where carcinomas of the oral cavity are treated with exposures of four or five hours a day for from ten days to two weeks, giving a total of 7,000 or 8,000 r-units. Under these conditions a severe erythema is produced, but it does not as a rule go to blistering, the lesion heals quickly, the skin remains soft, and the vas-

cular damage seems to be less than with softer radiation.

My own experience with this type of treatment has been very interesting, for I have seen the disappearance of large packets of nodes involved by squamous-cell epithelioma from the mouth, tongue, or larynx, when my previous radiation with 200 K.V., and 0.5 mm. copper filter, even exceeding an erythema dose had produced no effect. Of course, lower voltages with lower filtration are absolutely without influence on such tumors. In all probability, as I have shown, up to 550,000 volts, the wave length plays no part. The difference is in the timing and the depth dose, not any specific wave length. Nevertheless, many clinicians state that highly filtered radium in the form of a pack is more effective than the same amount of X-ray as measured by an erythema dose. Whether this is true or not must await accurate measurement of such radium doses in the same unit as we measure X-ray, and until that can be done, no comparison is possible. Clinical impressions, while useful, do not as a rule finally settle difficult problems of this sort. There is, however, one possibility. As you know, there are two types of electron scatter; one, of the so-called photo-electrons, the other, the recoil electrons. Now, observations in the Crocker Laboratory with flies' eggs, and measurements with physical instruments in other institutions, have shown that at about 180 K.V. back-scatter begins to diminish, and it has been stated that at 200 K.V. there are very few photo-electrons and all the scattering is of the recoil type. The curve of distribution of these two types is different. The photo-electrons come backward through the skin in almost the same quantity as they go forward through the tissues; at least, air measurements show this. The course of distribution of the recoil electrons is a pear-shaped curve, chiefly away from the direction of the impinging beam of X-rays. It may be that at still higher voltages, though this is not proved, there will be less and less back-scattering from these recoil electrons than occurs at 200 kilovolts. Such a problem, attacked both with measuring apparatus and biological material, is obviously one suited for the large experimental tube recently developed at the California Institute of Technology. If the scatter diminished with the increase of voltage, radium, the important radiation of which corresponds to about a million volts, should have less back-scatter to the skin than X-ray at 200 kilovolts. If so, even though the lethal process on the cells is independent of the wave length, a better depth dose, with less damage to the skin, may be obtained. So far, measurements of depth dosage of radium have not shown any great superiority for that agent, unless the source of the radiation is, as practised by the Regaud school, made very large. A paper by T. Marie (*Journal of Cancer Research*, 1927, XI, 377), entitled "The Value of Measurement of the Intensity of Radiation in Establishing a Rational Radiation Therapy," is of great interest. His measurements show that when radium needles are arranged in a suitable pattern over a large area, a great increase in the depth dose may be obtained. However, there is no evidence that the gamma rays of radium act upon individual tissue cells in any different way from that of the gamma rays given off by the X-ray tube. The destruction of the individual cell, which is probably due to the electron energy released in the cell, is accomplished, it is most logical to believe, by the slow-moving secondary and tertiary electrons, rather than by the high-speed ones. It is, therefore, theoretically improbable that there will be any difference between the effects of equal quantities of radiation of any wave length.

Practically, in order to get a better scatter factor and consequently a better depth dose, it may be necessary to use higher voltages

than are now available. One advantage in the higher voltages lies in the fact that the output of the tube rapidly increases with the voltage; just what this ratio is has not yet been decided. It has been estimated as the square of the voltage for unfiltered rays, but increases much more rapidly with high filtration. Whatever the ultimate truth is, with higher voltages the yield is greater, and the wave length shorter; hence larger quantities come through the same filter. It would be of great practical advantage if we could have tubes constructed to run at, say, three or four hundred thousand volts—a perfectly practical procedure. I have an experimental tube which has run at nearly three hundred thousand volts in air, and there would be no difficulty in constructing such a tube to run at three hundred or three hundred and fifty thousand volts in oil. That is merely a problem for electrical engineers. Such a tube might take a smaller milliamperage with the higher voltages, but the efficient yield through a copper filter of 2 mm. would be very much larger than with the present tubes. Another thing, with a larger yield, a greater number of patients can be treated, and this would meet the question of cost of which I have spoken.

In conclusion, some 80 per cent of all persons suffering from cancer are incurable by means of surgery. A few of these patients may be cured by radiation. More can have their lives prolonged over a considerable period of years by suitable radiation treatment. Another group can gain relief from pain, and a certain amount of psychic comfort in that they are being treated, even though there is no evidence that life is prolonged. Too much stress has hitherto been laid upon the attempt to produce permanent cures of incurable cancer by heavy radiation. The patient's life is too often rendered miserable by heavy dosage and in many instances I do not doubt the ante-mortem existence has been shortened by the attempt to accomplish the impossible. Radiologists should pay more attention to this group than formerly, as it is a fruitful field for therapy, and has been neglected in the past because of the vain hope of being able to produce a cure by heavy radiation.

DISCUSSION

DR. H. J. ULLMANN (Santa Barbara, Calif.): I want to emphasize what Dr. Wood has said about trying radiation treatment, no matter how hopeless the outlook may be, even for carcinoma of the stomach. Three years ago I was asked to treat a patient with gastric bleeding which was from, roentgenologically, a typical carcinoma of the stomach. As the man was slowly bleeding to death, it was hoped that roentgenization might check the bleeding—nothing more was hoped for. Following this treatment, the man got entirely well, and no trace of the gastric deformity could be demonstrated by barium meal. Of course, it was undoubtedly a malignant lymphoma, not carcinoma, but roentgenographically it was carcinoma. If he had not had radiation, he would have died; so we are now always willing to treat a carcinoma of the stomach as a therapeutic test, if the diagnosis of carcinoma has not been made by laparotomy and biopsy. I have had a number of ovarian tumor cases, and while autopsies have been performed on most of them, I am still willing to try treatment, as I have had several that have gone for a number of years. I feel very strongly, as Dr. Wood does, that patients should not be left to die, but should be treated in all cases, for, if this is done, there will be a small, but definite, percentage of cures in what are otherwise hopeless situations.

ABSORPTION MEASUREMENTS OF THE X-RAY GENERAL RADIATION[1]

By LAURISTON S. TAYLOR, WASHINGTON, D. C.

Abstract.—Studied as a means for indicating the quality of the radiation, copper absorption curves for heterogeneous X-rays were obtained, using a standard and two thimble ionization chambers. With the standard air chamber, logarithmic absorption curves were not found to become straight for filters up to 3 mm. in thickness—indicating a gradual elimination of the longer wave lengths. With thimble chambers, owing presumably to errors from the chamber "wall effect," the curves were non-linear only up to 1 mm. thickness of filter.

Half value layers and effective wave lengths derived from the three sets of results were compared. The "effective wave length" as derived from the slope of the absorption curve and the "half value layer" are about equally sensitive to changes in quality, at least up to 3 mm. thickness of filter. As should be expected, effective wave lengths thus obtained are always longer than those obtained by Duane's finite filter method and, being less dependent upon the particular instrument used in the measurements, are, therefore, more consistent.

On the basis of the effective wave length determinations it is found that, contrary to the accepted views, the greater part of the highly filtered energy is not concentrated in the tungsten K lines.

I. INTRODUCTION

IN connection with the proper control of X-radiation in its various applications, reliable and relatively convenient means of measuring the radiant energy is the first necessity. This part of the problem seems to be satisfactorily solved by observing proper care in the design and use of the ionization chamber. The Bureau has, therefore, announced its completion of a standard ionization chamber.[2] The next project on this program is the study of possible methods of determining "quality" of radiation. The accuracy with which it is necessary to describe the quality depends, of course, upon the particular use to which the radiation is put. In radiological practice an accuracy of 3 to 4 per cent may be sufficient, whereas in precise physical experiments the accuracy should be better, as indicated, for example, in the recent papers by Compton,[3] and Crowther and Bond.[4]

In the radiological field recent work by Pohle and Barnes,[5] Quimby,[6] and Burby and Barry[7] has shown large discrepancies in the qualities of the different X-ray beams as measured by different methods. Moreover, Quimby showed that three beams having the same "quality," according to some Method A, had radically different "qualities" according to another Method B. It thus appeared desirable to make a fairly comprehensive study of available methods and the devices used in applying them.

Inasmuch as a beam of X-rays may cover a range of wave lengths which are unequally effective in producing the results sought, next in importance to measuring the total energy is that of determining the distribution of the energy among the wave lengths present. A direct measurement of spectral energy distribution is the most reliable and satisfactory way of describing the quality of the radiation, but this is so difficult and cumbersome that the method eliminates itself from the field of practical applications.

[1] Reprinted from Bureau of Standards Journal of Research. Research Paper No. 212, September, 1930.
[2] RADIOLOGY, April, 1930, XIV, 416; Am. Jour. Roentgenol. and Rad. Ther., 1930, XXIII, 316.
[3] A. H. Compton, Phil. Mag., 1929, VIII, 931.
[4] J. C. Crowther and W. N. Bond, Phil. Mag., 1928, VI, 401.
[5] E. A. Pohle and J. M. Barnes, RADIOLOGY, 1928, X, 300.
[6] E. H. Quimby, Am. Jour. Roentgenol. and Rad. Ther., 1929, XXI, 275.
[7] J. J. Burby and M. W. Barry, RADIOLOGY, 1929, XII, 275.

Fairly sound substitute methods of greater utility have been based on the degree of absorption of the total energy by filters of standard materials (copper, silver, aluminum, etc.), knowledge of the incident radiation being inferred from the absorption measurements of various filter thicknesses.

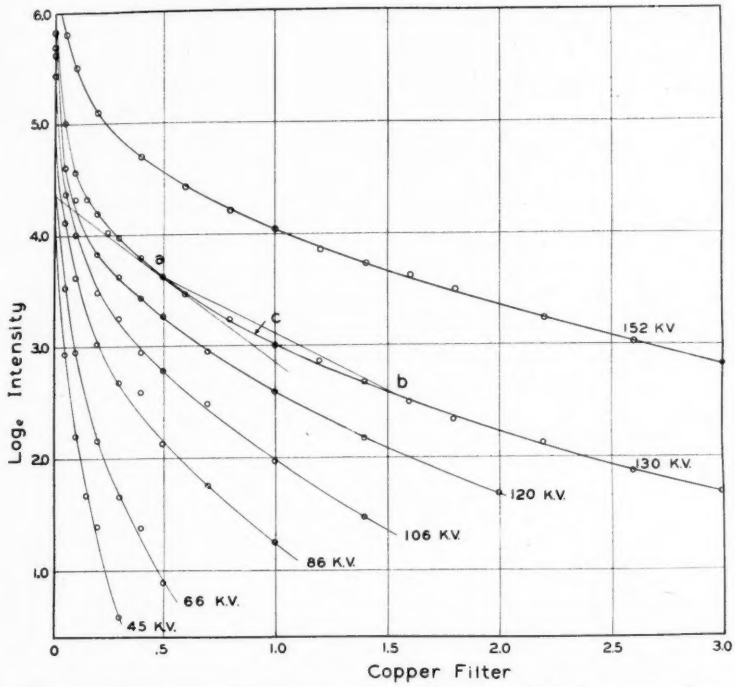


Fig. 1. Copper absorption curves made with standard air ionization chamber for practically constant voltage X-rays.

Even if the ionization spectrometer method of mapping the spectral radiation were not so difficult and cumbersome under present conditions, it would still be far from an ideal method owing to the many conditions involved, some of which are not well understood. The more common forms of the X-ray spectrograph as substitute for the ionization spectrometer are inadequate, for, due to such factors as X-ray scattering, photographic halation and spectral sensitivity of the emulsion, a simple density curve of the photographic plate may be very misleading. In using such data to determine minimum wave length,[8] it is necessary to extrapolate the curves to zero energy by starting at some point well up on the established curve, which, of course, makes for very uncertain conclusions.

With these facts in mind the best method, for practical purposes, for arriving at the quality of any given X-ray beam seems to be that involving direct absorption measurements.

In deep therapy wave length ranges, Duane has shown that absorption measurements in copper are well suited for describing the quality.[9] In the superficial therapy range, either copper or aluminum absorption measurements[10] may be used; and, in

[8] A. Mutscheller, RADIOLOGY, 1929, XII, 283.
[9] William Duane, Am. Jour. Roentgenol., 1922, IX, 167.
[10] William Duane, Am. Jour. Roentgenol. and Rad. Ther., 1928, XX, 241.

the "Grenz-therapie" range, most observers have used very thin aluminum absorbers.[11, 12, 13]

In their technical production, various types of high voltage generator are used, many having a characteristic wave form and, hence, furnishing X-rays of periodically varying quality. If the peak voltage of such a generator remains constant, however, the radiant energy at all wave lengths integrated over any practical interval of time, will be proportional to that interval; and the resulting spectral energy distribution may be treated as constant. This is not merely an obvious assumption, but is supported by experience in that it has been found that essentially the same quality of radiation may be obtained from mechanical rectifiers as from constant potential sources if the rectifier be operated at a slightly higher peak voltage than the "constant voltage" source.

The present study has been confined throughout to a practically constant potential source,[14] inasmuch as this makes for more ready definition of the spectral energy distribution.

II. THEORY OF ABSORPTION MEASUREMENTS

1. Absorption of Heterogeneous Radiation

Representing by E_λ the energy between the wave lengths λ and $\lambda + d\lambda$ of the beam, the total energy (E) of a continuous X-ray spectrum, void of characteristic lines, may be expressed as an integral between the short wave length limit $\lambda = \lambda_0$, and $\lambda = \infty$; that is,

$$(E) = \int_{\lambda_0}^{\infty} E_\lambda \, d\lambda \qquad (1)$$

If the form of E_λ is known, the total energy (E) may be calculated. The magnitude of E_λ as it varies with λ has been derived theoretically by Behnken,[15] who found fair agreement between his theoretical and Ulrey's[16] experimental curves for constant potential X-rays. A more recent combined experimental and theoretical study by Kulenkampff[17] has revealed even better agreement between theory and experiment. In the present work we are concerned, however, with the problem of deducing some knowledge of the spectral distribution E_λ from measurements of the total energy (E) after passage through properly chosen filters.

If a filter of thickness x intercept a beam of radiation, the incident energy E_λ comprised between the wave lengths λ and $\lambda + d\lambda$ will be reduced by the filter to a quantity of energy E'_λ, emerging from the filter, of a magnitude given by the well-known equation

$$E'_\lambda = E_\lambda \, e^{-\mu_\lambda x} \qquad (2)$$

where μ_λ is the "absorption coefficient" of the material of the filter for the radiation of wave length λ. Here, of course, scattering is neglected.

The value of μ_λ for copper or other material may be obtained from tables or computed from Richtmyer's[18] formula for the "mass absorption coefficient" $\frac{\mu_\lambda}{\rho}$, in which

$$\mu_\lambda/\rho = A\lambda^3 + K \qquad (3)$$

A and K being constants for the given material and ρ the density of the material.

For copper between $\lambda = 0.12$ and 0.30 Ångströms, Richtmyer found[19]

$$\mu_\lambda/\rho = 153\lambda^3 + 0.2 \qquad (3a)$$

λ being expressed in Ångströms and μ in cm^{-1}.

From an inspection of Equation (3) it is obvious that any filter inserted in a heterogeneous beam will absorb the longer wave lengths more than the shorter and, hence,

[11] O. Glasser and U. V. Portmann, Am. Jour. Roentgenol. and Rad. Ther., 1928, XIX, 442.
[12] H. Küstner, Strahlentherapie, 1927, XXVII, 124.
[13] L. E. Jacobson, Am. Jour. Roentgenol. and Rad. Ther., 1929, XXII, 544.
[14] L. S. Taylor, Bureau of Standards Jour. of Research, 1929, II (R. P. 56), 771.
[15] H. Behnken, Ztschr. f. Phys., 1921, IV, 241.
[16] C. T. Ulrey, Phys. Rev., 1917, IX, 548.
[17] H. Kulenkampff, Ann. d. Phys., 1922, LXIX, 548.
[18] F. K. Richtmyer, Phys. Rev., 1921, XVIII, 13.
[19] F. K. Richtmyer and F. W. Warburton, Phys. Rev., 1923, VI, 539.

"harden" the radiation. This means is used in practice. Furthermore, the degree of hardness of the radiation transmitted by any given filter may be indicated by the extent to which a second additional filter inserted in the beam absorbs the radiation transmitted by the first. It is this application with which we are here concerned.

2. Application of Absorption Measurements in Describing X-ray Quality

(A) Effective Wave Length.—One method, which makes use of absorption measurements for obtaining an indication of the quality of an unknown heterogeneous radiation of energy (E), is that which determines the wave length of the homogeneous radiation which would be reduced in intensity by a given filter in the same degree as the heterogeneous radiation is reduced by it. The heterogeneous radiation is then designated as having an *effective wave length* equal to that of its corresponding homogeneous radiation.

For example, Equation (2) relates the transmitted to the incident radiation of wave length λ through the thickness of the filter x and the absorption coefficient μ_λ.[20] Taking now the incident and transmitted heterogeneous energies (E) and (E') we we may use a *composite absorption coefficient*[21] μ, such that

$$(E') = (E)e^{-\mu x} \qquad (4)$$

Having the values of μ_λ, either from tables or Equation (3a), either (E) or (E') may be said to have that effective wave length λ_e for which

$$\mu = \mu_\lambda \qquad (4a)$$

or, if x be taken sufficiently small, both may be assigned the effective wave length in question.

Duane uses a filter of given material and of finite thickness x for obtaining the effective wave length of the radiation incident thereon.[22] The results of a comparative experimental study of this, and that of an infinitesimal thickness of filter with different available devices for measuring the energy of the beam, was the partial object of the present investigation.

Illustrations of the two methods of determining effective wave lengths are to be found in Figures 1 and 4 where, with increasing thickness of filter, the logarithm of the transmitted energy is plotted against thickness of a given filter material. Let, in Equation (4), (E') be the energy at any thickness x', and (E'') that at a thickness $x'' = x' + x$; then Duane's method applied gives

$$(E') = (E)e^{-\mu' x'} \qquad (5)$$

$$(E'') = (E)e^{-\mu'' x''} \qquad (6)$$

From this

$$\log \frac{(E')}{(E)} - \log \frac{(E'')}{(E)} = \mu'' x'' - \mu' x' \qquad (7)$$

Noting that μ' in Equation (5) depends on the entire thickness x', and μ'' in Equation (6) depends on the same thickness of filter plus the increase $x = x'' - x'$, it appears at least approximately correct within limited ranges to use an intermediate value of μ such that

$$\mu = \frac{\log \frac{(E')}{(E)} - \log \frac{(E'')}{(E)}}{x} \qquad (8)$$

Here μ is dependent upon x as well as upon (E') and (E''). If, however, x be taken small enough, equal to $\triangle x$, so that the filter does not appreciably change the quality of the radiation passing through it, and yet produces a measurable change in the energy of the beam, then

$$\mu = \frac{\triangle \log \frac{(E')}{(E)}}{\triangle x} \qquad (9)$$

is represented by the slope of the curve $\log \frac{(E')}{(E)}$ plotted against the thickness of filter x.

[20] L. S. Taylor, RADIOLOGY, 1929, XII, 289.
[21] A. H. Compton, "X-rays and Electrons."
[22] William Duane, Proc. Nat. Acad., 1927, XIII, 668.

The effective wave length as defined by Duane[23] is "the wave length of monochromatic radiation that would produce the same effect (readings of the instruments employed, etc.) that the actual radiation produces." His method of measurement consists in determining the percentage transmission of the given filter for the given radiation, then determining λ_e from previously constructed calibration curves, as obtained from the absorption law indicated in Equations (2) and (3).

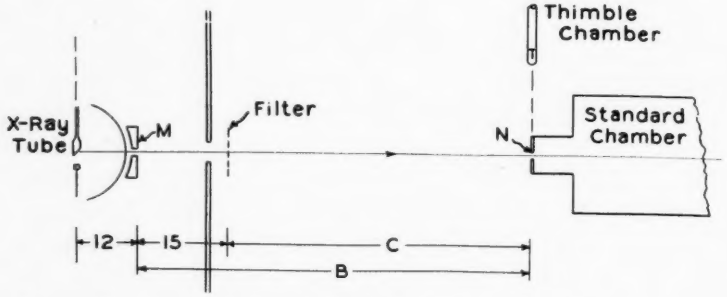


Fig. 2. Diagram of X-ray tube-filter-ionization chamber system.

The so-called "true effective wave length" is independent of any given filter thickness; and, in that one other factor is thus eliminated from its determination, it is physically a more desirable way to express the quantity sought. For its determination, a logarithmic absorption curve is established with a series of filters of increasing thickness and the slope at the point in question gives directly the composite absorption coefficient μ. From monochromatic wave length absorption curves or Richtmyer's formula (Equation (3a)) may thus be determined, as the true effective wave length λ_e, the single wave length which has the same absorption coefficient.

A "bracket" method for obtaining λ_e may also be used wherein two intensity measurements are made for filter thicknesses equally above and below the filter for which the radiation quality is desired. The absorption coefficient and corresponding λ_e is then obtained from the difference of the logarithms of these two intensity measurements, it being assumed that this absorption coefficient is the same as that corresponding to the intermediate filter. Such a method, while nearer the tangent method (true λ_e) than Duane's, does not make full allowance for the curvature of the logarithmic absorption curve between the points taken.

The bracket method is exactly the same as Duane's method as far as the operational procedure is concerned, except that the radiation for which λ_e is determined corresponds more nearly to that of the intermediate filtration instead of the smaller filtration. By Duane's method the ratio of the two intensities $(E')/(E'')$ for filtrations x' and x'' is said to give λ_e for the filtration x' whereas the bracket method gives λ_e for a filtration close to $(x' + x'')/2$. As shown later, the difference between the two varies according to the range in which the measurements are applied, and may be neglected for many practical purposes.

In Duane's earlier work he specified the use of 1 mm. of copper for obtaining the effective wave length. The use of such a large filter-difference will give reasonably consistent agreement with the true λ_e only

[23] William Duane, Am. Jour. Roentgenol. and Rad. Ther., 1928, XX, 241.

for very high filtrations as shown in Table II and when used according to the bracket method (Equation (8)). For lower filtrations the differences between the two methods increases. In later work he specified the use of 0.25 mm. filter separation, thus increasing considerably the range over which λ_e might be determined with fair agreement with the other method (true λ_e).

Duane also indicated at the time that small errors in the measurement of filter thickness may cause an appreciable error in the determination of λ_e by his method. The effect on λ_e of errors in thickness will, of course, be greater for the method using 0.25 mm. filter separation than for the 1 mm. method. In the case of obtaining λ_e from a complete absorption curve such errors are averaged out.

(B) Half Value Layer.—One of the earliest methods of describing the quality of a heterogeneous X-ray beam was to measure the absorption by a series of filters of some material and then determine from the absorption curve the thickness of that material which would reduce the intensity of the given beam to one-half its initial value. If, for example, a beam has an intensity of E_{F1} after passing through a filter of thickness x_1, and E_{F2} is the half-intensity $(E_{F1}/2)$ after passing through a filter $x_1 + x_2$, then x_2 is the half value layer of the particular material for that radiation which has passed through x_1. While then the quality is expressed by the effective wave length as determined by a given thickness of filter of given material, the half value method expresses the quality in terms of the thickness of filter (of given material) required to reduce the intensity by a given amount (one-half).

Obviously, the shorter the effective wave

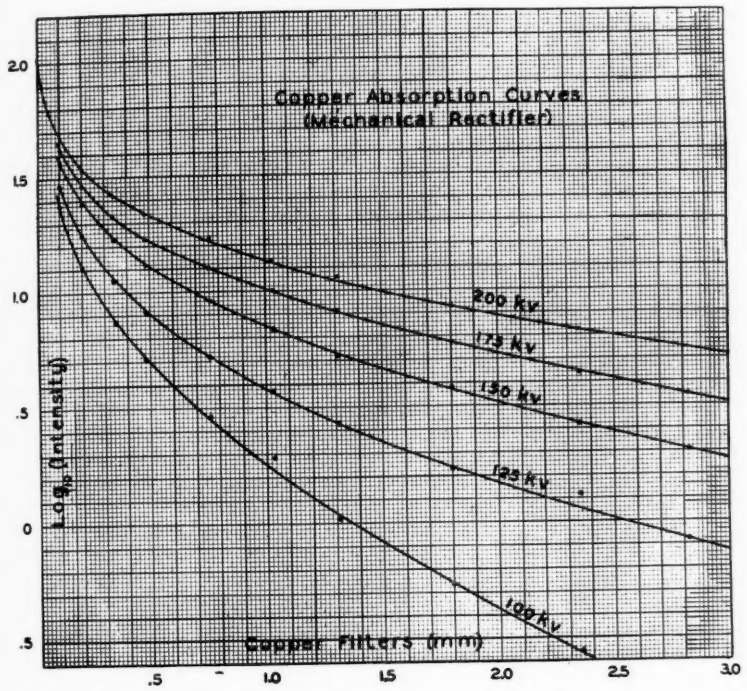


Fig. 3. Copper absorption curves made for mechanically rectified voltage.

length of the given radiation, the thicker this half value layer of filtering material must be. Inasmuch, therefore, as the composite absorption coefficient μ of Equation (4) varies with the thickness x of the added filter, there is no simple direct quantitative relation connecting effective wave length with half value layer.

Comparing the half value layer and effective wave length method, the latter has the advantage in that it presents a clearer physical picture of the radiation quality.

In roentgenological practice, the voltage wave forms are usually of two general types, being either approximately constant or approximating a sine wave; and the target material is always tungsten. Here the half value method has served as a useful approximation for expressing the radiation quality. However, as a particular example, it is unsafe to rely on this method for comparing qualities of two radiations, one excited by constant and the other by a fluctuating voltage. Quimby[24] made a detailed study of the qualities of various radiations, all having the same half value layer of copper, and found large differences among them.

The inset (*A*) in Figure 5 shows a plot of the half value layer taken from the absorption curve in Figure 5, for filtrations as high as 1.6 mm. of copper. Investigations cited[25] have indicated that such a curve would be different for each voltage wave form applied to the tube.

(C) Average Wave Length.—This method was proposed by Mutscheller[26] several years ago. It follows the true effective wave length method in that from the tangent to a heterogeneous radiation absorption curve a coefficient of absorption is determined from Richtmyer's tables with which the corresponding monochromatic wave length is identified. He definitely divides his measurements into two classes, those for the portion of the absorption curve from zero to the "homogeneity filter"[27] and those beyond this point.

According to the results presented in this paper there can be no "homogeneity filter," strictly speaking. Practically a filtration may be reached beyond which the radiation quality changes comparatively little—the absorption curve approaching linearity.

In most of his published absorption curves he shows such linearity above about 0.5 mm. copper filtration, indicating the attainment of effectively homogeneous radiation. There is no evidence that such a condition should be rigidly true and it is not reached within the range of filtration (0 to 3 mm. Cu) used in this paper. It appears, therefore, that the average wave lengths so obtained in the region beyond the "homogeneity filter" are subject to errors larger than herein contained; that is, Mutscheller's method is that of the true effective wave length above but applied in the range where the errors are such as to render the results questionable. Applied in the region below the "homogeneity filter"—that is, for small filtrations—his method is identical with the so-called true effective wave length method.

III. EXPERIMENTAL RESULTS

1. Comparison of Different Ionization Chambers

In the development thus far we have dealt with ideal conditions wherein it has been considered possible to make direct energy measurements. However, in applying absorption measurements as an indication of the quality of a given X-ray beam, the ionization current produced by the beam is the quantity measured. The current per unit energy does not change rapidly with wave length, and for simplicity we will speak of this as energy, understanding, of course, that the measured ionization is pro-

[24] E. H. Quimby, Am. Jour. Roentgenol. and Rad. Ther., 1929, XXI, 64.
[25] See Footnotes 5, 6, 7, and 29.
[26] A. Mutscheller, RADIOLOGY, May, 1924; October, 1924; April, 1929.
[27] E. A. Pohle, RADIOLOGY, 1928, X, 300.

portional to the energy absorbed from the beam by the air in the ionization chamber.

The results of absorption measurements made by a number of observers are not in close agreement; consequently the technic of making such measurements has been studied in the greater detail given here.

In some recent work at this laboratory a study was made of the calibration of the thimble ionization chambers against a standard air ionization chamber[28] in which it was brought out that there was a marked difference in the copper absorption curves for the same radiation when measured with several different thimble ionization chambers and the standard chamber.

In Figure 1 is shown a series of semilogarithmic copper absorption curves obtained by measuring the incident and transmitted intensities with the standard air ionization chamber. The tungsten X-ray tube was operated at practically constant potential, as recently described. The diaphragming system[29] to limit the beam was in accordance with the necessary conditions to make an accurate determination of the effective intensity of the beam in roentgens.[30] When a thimble ionization chamber was used, it also was in accordance with previously described technic.[31, 32] The configuration of the system in Figure 2 shows the arrangement diagrammatically, and is self-explanatory.

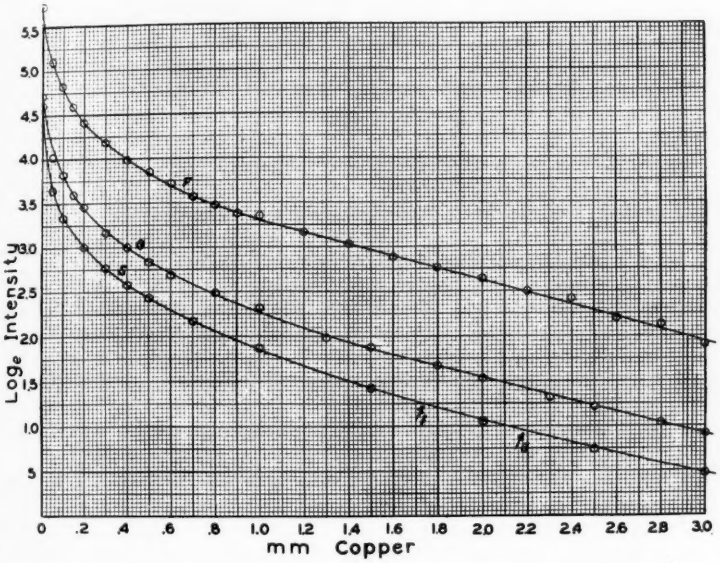


Fig. 4. Copper absorption curves made for 133 K.V. radiation, using three different chambers.

For the curves shown in Figure 1 the diaphragms M and N each had a radius of 12 mm. and the interdiaphragm distance B was 65 centimeters. The filters were 15 cm. from M, thus making the distance C between filter and chamber diaphragm 50 centimeters. In taking these data the precision of observation for a single filter was about ± 0.2 per cent. The copper filters had a

[28] L. S. Taylor and G. Singer, Bureau of Standards Jour. of Research, 1930, IV (R. P. 169), 631.
[29] L. S. Taylor, Bureau of Standards Jour. of Research, 1929, II (R. P. 56), 771.
[30] L. S. Taylor, Bureau of Standards Jour. of Research, 1929, R. P. 119, p. 807.
[31] See Footnote 28.
[32] L. S. Taylor, Radiology, 1930, XIV, 551.

TABLE I

Filter	Standard		Friedrich		Glasser	
	I_S	$\log_e I_S$	I_F	$\log_e I_F$	I_G	$\log_e I_G$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	100.0	4.60	312.0	5.74	111.0	4.71
.05	38.4	3.65	164.0	5.10	55.7	4.01
.1	28.6	3.355	123.0	4.81	45.4	3.82
.15			99.0	4.58	35.7	3.58
.2	20.0	3.00	81.6	4.40	30.4	3.46
.25	(17.8)		72.6	4.285	(26.8)	
.3	16.1	2.78	66.3	4.194	23.8	3.16
.4	13.0	2.56	53.6	3.98	20.0	3.00
.5	11.5	2.44	48.1	3.87	17.2	2.84
.6			41.2	3.72	14.8	2.69
.7	8.70	2.16	35.6	3.57	(13.4)	
.8			32.5	3.48	12.1	2.495
.9			29.8	3.39		
1.0	6.49	1.87	28.8	3.36	10.2	2.315
1.2	(5.4)		23.6	3.16	(8.4)	
1.3					7.35	1.99
1.4			20.8	3.035		
1.5	4.11	1.43	(19.4)		6.62	1.89
1.6			18.0	2.89		
1.8			15.8	2.76	5.26	1.66
2.0	2.86	1.05	14.2	2.65	4.58	1.52
2.2			12.2	2.50		
2.3					3.72	1.31
2.4			11.2	2.42		
2.5	2.08	.733			3.36	1.21
2.6			9.0	2.20		
2.8			8.5	2.14	2.84	1.04
3.0	1.60	.469	6.7	1.90	2.56	.714

tested purity of 0.99998 and their thicknesses were uniform to within ± 0.002 millimeter. It is clearly evident that for the curves shown there is no straight portion up to a copper filtration of 3 mm., although it is apparent that they are asymptotically approaching a straight line. A large number of other such curves were obtained under varying conditions of the distance B and the diaphragms M and N, and all were exactly similar to those shown.

In order to be certain that no peculiarity of this system could be responsible for the form of these curves, I have obtained through the courtesy of Dr. Failla and of Dr. Quimby, of Memorial Hospital, New York City, the set of absorption curves for tube potentials up to 200 K.V., shown in Figure 3. These were made some months previously with a thimble air wall ionization chamber differing slightly in construction from that used at the Bureau. Here also it is clearly evident that the absorption curves do not become straight.

Attention may also be called to a paper by Rump,[33] in which is given a similar series of absorption curves for potentials up to 150 K.V. (Fig. 5 in his article). Again, it is found that the curves are non-rectilinear. In view of the excellent agreement of these different workers there seems no question of the validity of the results.

The same type of copper-absorption meas-

[33] W. Rump, Ztschr. f. Phys., 1927, XLIII, 254; 1927, XLIV, 396.

urement was next made with several thimble ionization chambers placed at various distances from the filter, but all for the same beam of radiation. It must be pointed out that the precision of observation with such ing the filter position. For the standard ionization chamber no measurable effect was produced by moving the filter from 0.5 to 30 cm. from the entrant diaphragm. However, shifting the filter over the same range

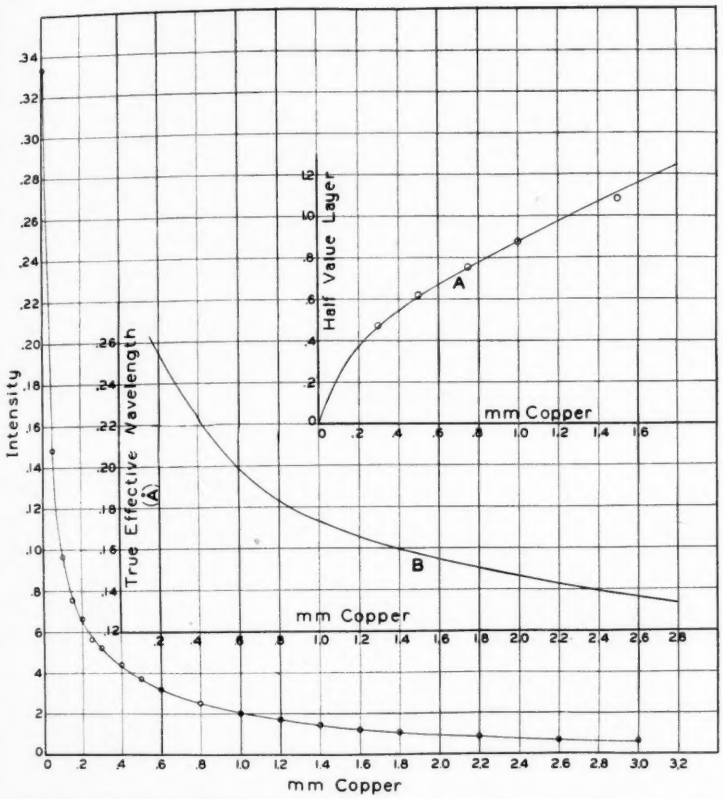


Fig. 5. Curves showing half value layer and true effective wave length obtained from the same absorption curve.

chambers is not as great as with a standard air chamber, and consequently we can not place the same reliance on the measurements made with them.

In order to be certain that the position of the ionization chamber with respect to the filter did not influence the measurements, a series of intensity readings were made, keeping the chamber fixed and changfor a thimble chamber, the measured intensity fell off steadily up to a distance of about 10 cm., where it reached a steady value. Consequently, all measurements with a thimble chamber were made at least 15 cm. from the filter.

In Figure 4 are shown three semilogarithmic absorption curves: *S*, obtained with a standard; *G*, with a Glasser thimble cham-

ber, and F with a Friedrich thimble chamber. The X-ray tube was operated at 133 K.V., D.C., for all. The standard chamber was set 45 cm. from the filter and the Glasser chamber and Friedrich chamber at about 15 centimeters.

The original data for these curves are given in Table I. The intensities I_F and I_G, as measured with the Friedrich and Glasser chambers, respectively, have each been corrected for a very small natural leakage. There was no measurable leakage in the standard chamber system. Half value layers obtained from these data were in good agreement with Holthusen's curves for the voltage used,[34] both measurements being made with a standard chamber.

It is seen that the curve obtained with the standard chamber does not become straight for filtration up to at least 3 mm. of copper. For Curve F, obtained with the Friedrich chamber, however, it is equally possible to pass a straight line or a slightly curved line through the points above 1 mm. filtration. Likewise for Curve G, obtained with the Glasser chamber, the points above 1.5 mm. could be joined by a straight or curved line, although the former is perhaps the better of the two. Straight lines are shown in both cases to illustrate a possible explanation for the absorption curves shown invariably by Mutscheller, his curves usually having been obtained with thimble chambers.

If now we measure the slopes of the curves, we find that F and G have straight portions with slopes —6.80 and —6.28, respectively. The points marked f and g on the standard absorption curve have also these slopes of —6.80 and —6.28, respectively. Thus for a given beam of X-rays we apparently find an absorption coefficient which varies considerably according to the technic used in measuring it. To attain uniformity the most logical consequence seems to be to discard the thimble chamber as a means for making precise measurements; for, inasmuch as the open air chamber is free from wall effects and is the accepted standard, it is apparently the best available means for making absorption measurements of the general radiation.

Where, in practice, a thimble chamber is used in making precise quality measurements, care should be taken to correct for the wall effect.

2. *Comparison of Quality Measurements*

Having reviewed the methods of making quality measurements, we shall now compare the results obtained by applying each method to the same heterogeneous beam of X-rays generated by a practically constant potential source of voltage.

In order to better co-ordinate this comparison we shall refer all measurements of quality to those of the so-called true effective wave length without meaning to imply thereby that this method is preferable or necessarily the most correct. It is, however, less arbitrary than other methods.

Through the courtesy of Prof. H. Holthusen, of Hamburg, a family of curves was available, showing the relation between the half value layer in copper and the tube voltage (constant) for a series of filtered radiations. Half value layers were obtained from each of his curves at points corresponding to 130 K.V. and plotted as circles in the H. V. L. curve. (Inset A in Fig. 5.) The excellent agreement of our experimental results with Holthusen's shows the reliability of the H. V. L. method for constant potential, and gives further proof of the correctness of our above-mentioned experimental procedure.

We may now make a simple comparison of the effective wave length obtained by the slope and bracket methods. For example, if we were to take as the absorption coefficient the slope of the line joining the two points a and b on the absorption curve (Fig. 1), corresponding to filters of 0.5 and 1.5 mm. of copper, this would give the slope cor-

[34] H. Holthusen, RADIOLOGY, 1928, X, 292.

TABLE II

Filter	Slope μ	True λ_e	Bracket λ_e		Equivalent filter	Duane λ_e	H. V. L. Cu
			μ	λ_e			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mm.	*cm.*$^{-1}$	*Å.*	*cm.*$^{-1}$	*Å.*	*mm.*	*Å.*	*mm.*
0.1							0.238
.2	25.5	0.256					
.25	22.8	.243					
.3	19.9	.230					.475
.4	17.5	.224				0.183	.56
.5	15.4	.207	28.0	0.262	0.15	.178	.62
.6	14.4	.202	16.6	.214	.45	.172	.68
.7	12.8	.192	13.8	.198	.6	.168	.73
.8	11.4	.184	12.2	.189	.7	.164	.79
.9	10.5	.178	11.3	.183	.8	.161	
1.0	9.86	.174	10.5	.178	.9	.158	.86
1.1	9.25	.170	9.6	.172	1.05		
1.2	8.64	.165	9.0	.168	1.15	.153	1.00
1.3	8.40	.163	8.5	.164	1.25		
1.4	7.94	.160	8.1	.161	1.37	.148	1.04
1.5			7.8	.158	1.45	.144	
1.6	7.53	.156					1.18
1.7			7.2	.153	1.8		
1.8	7.15	.153					
1.9			6.7	.148	1.9		
2.0	6.42	.146					
2.1			6.2	.144	2.1		
2.2	5.98	.142					
2.4	5.80	.140					
2.6	5.40	.136					
2.8	5.25	.134					

responding to a filtration of 0.9 mm. at the point C instead of at 1 millimeter. If the points 1 and 2 mm. were chosen instead, the effective wave length would be much more nearly the correct value at 1.5 millimeters. For small filtrations the error in the bracket type of measurement is considerable. Above a certain filtration the method may be sufficiently accurate for many purposes. It has the advantage of requiring but two measurements.

From Equation (8) the absorption coefficient μ is given by

$$\mu = \frac{1}{x} \log_e \frac{(E')}{(E'')} \qquad (10)$$

where (E') and (E'') are the intensities after passing through the two copper filters differing in thickness by x centimeter. If, for example, we wish to find μ for 133 K.V. radiation filtered through 1 mm. of copper, we have from Table I, Column 3, $\log_e (E') = 2.44$ for filter 0.5, and $\log_e (E'') = 1.43$ for filter 1.5 millimeters. This gives $\mu = 10.1$ and $\lambda_e = 0.174$ Å. Comparing this with the true effective wave length for 1 mm. copper filtration (Table IV, Column 3) we find a value of 0.169 Å. for the true effective wave length, a fairly good agreement.

A series of values of λ_e for 130 K.V. radiation obtained by the bracket method (where $x = 1$ mm.) are given in Table II.

A summary of the absorption measurements is shown in Table II wherein all the calculations are taken from the absorption curve at 130 K.V. (Fig. 1). Column 2 gives the slope of the curve at points corresponding to the different thicknesses of

the copper filter indicated in Column 1. Since the curves were plotted with Naperian logarithms, Column 2 thus gives directly the coefficient of absorption μ for each quality of radiation. Column 3 gives the corresponding true effective wave lengths when the values of μ are put in Richtmyer's copper absorption coefficient curves for monochromatic radiation. From this it is seen that the effective wave length varies appreciably for filtrations up to 2.8 mm. at least. A plot of the effective wave lengths is shown in Inset B of Figure 5.

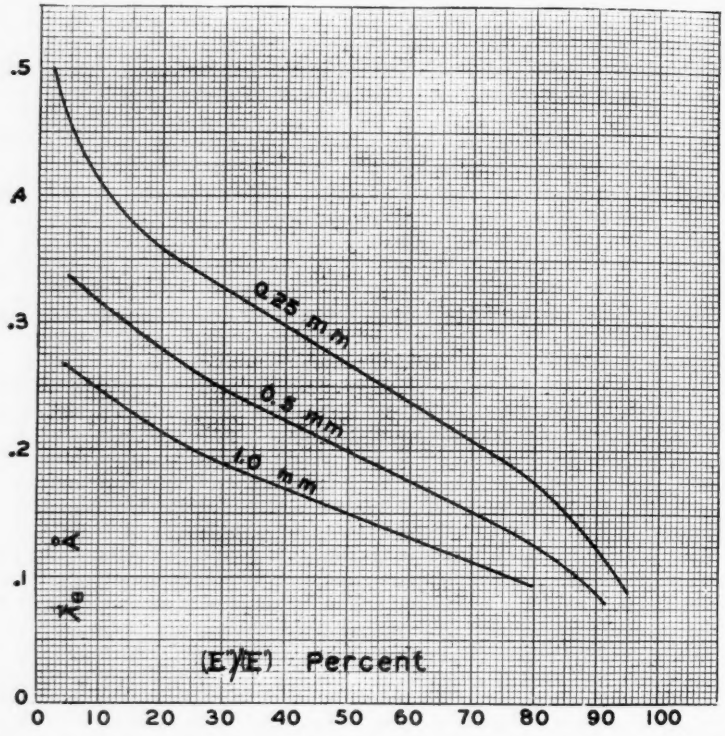


Fig. 6. Effective wave length as a function of the percentage transmission through given filters of finite thickness.

Column 4 gives the value of the absorption coefficient obtained by the "bracket" method (Sec. II, 2 (*a*)) wherein the coefficient is given by the slope of the line joining two points on the logarithmic absorption curve, corresponding to a filter separation of 1 millimeter. The intermediate filtration of the two is that shown in Column 1. Column 5 gives the effective wave lengths corresponding to the absorption coefficients of Column 4, from which it is seen by comparison with Column 3 that, as should be expected, the values approach the same limit for higher filtrations. Column 6 gives the approximate filter thickness on the true absorption curve for the effective wave lengths of Column 5, thus indicating the divergence in terms of filter thickness. For example, consider a beam having an initial filtration of 0.6 mm. copper. Its true effective wave length is 0.202 Å., whereas that derived by the "bracket" method is 0.214 Å. and would correspond to a filtration of about 0.45 mm.

on the logarithmic absorption curve. Such a discrepancy shows at once that the bracket method, using a filter separation of 1 mm., is not satisfactory for obtaining effective wave lengths in close agreement with the true effective wave length except for higher filtrations.

Column 7 gives the effective wave lengths obtained by Duane's method, using a 1 mm. filter separation, from which it is seen that the difference between λ_e, as obtained by the slope of the curve and as obtained by Duane's method, is large over the whole range of filtrations used. Applying the same measurements, however, we obtain a fairly good measure of λ_e for the radiation corresponding to the average filtration. Thus for 0.7 mm. initial filtration, the true effective wave length is 0.192 Å.; by the 1 mm. bracket method, 0.198 Å., whereas by Duane's (1 mm.) method, 0.168 Å. When comparing Duane's effective wave length using 0.25 mm. copper with the true effective wave length, the differences are not large except for unfiltered or lightly filtered radiation.

From the practical standpoint we must not ignore the advantages of Duane's method. It requires but two intensity measurements with given filters and reference to a predetermined calibration curve; it is sufficiently accurate for many of the present-day medical needs.

The half value layers in copper for the same radiation are given in Column 8 and it is seen that, throughout the entire length of the absorption curve, these are decreasing continuously at least up to an initial filtration of 1.6 millimeters. The data of Column 8 are plotted in Insert A of Figure 5. As pointed out in (II, 2 (*c*)), there can be no fixed relation between the half value layer and effective wave length except for strictly constant potential X-rays. Curves showing the relation between the two have been given by Neeff and Reisner[35] and others under different conditions, but none lead to any co-ordinated relationship.

Table III shows the results of determining the effective wave length of the unfiltered radiation by Duane's method, using both a standard (*S*) and a thimble (*F*) ionization chamber for the intensity measurements. Column 1 indicates the type of chamber used; Column 2 is the filter thickness used in the determination of λ_e ; Column 3 gives the percentage transmission of the respective filters for which are given the corresponding values of λ_e in Column 4, obtained from Duane's curves for effective wave lengths.

It is interesting to note, for lightly filtered radiation, how dependent is the measurement of λ_e on the type of ionization chamber used. For example, in the first case λ_e differs by 8.1 per cent for the two chambers, while the respective percentage transmis-

[35] T. C. Neeff and A. Reisner, Strahlentherapie, 1929, XXXII, 190.

TABLE III

Chamber	Filter	E/E_o	λ_e (Duane)	Percentage difference E/E_o	Percentage difference λ_e	λ_e calculated
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	mm.	*Per cent*				
S	0.25 Cu	17.7	0.37	22.4	8.1	0.368
F	.25 Cu	23.3	.34			.343
S	1.0 Cu	6.5	.26	30.9	7.5	.263
F	1.0 Cu	9.4	.24			.234
S	2.0 Al	41.8	.47	11.6	4.2	.....
F	2.0 Al	47.3	.45			.....
S	4.0 Al	27.4	.41	15.1	2.5	.....
F	4.0 Al	32.3	.40			.....

TABLE IV

Chamber	Filter	True λ_e	Percentage difference, standard	Bracket λ_e	Percentage difference, bracket and same chamber	Percentage difference, standard	λ_e Duane	Percentage difference, Duane and same chamber	Percentage difference, standard
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Standard	0						0.37		
	.25	0.247		0.248	+0.4		.222	—11.3	
	.5	.207		.204	—1.5		.192	—7.8	
	.75	.185		.184	—.5		.177	—3.9	
	1.0	.169		.169	0		.167	—1.2	
Friedrich	0						.34		
	.25	.241	—2.4	.249	+3.2	+0.8	.222	—8.3	—11.3
	.5	.210	—1.4	.205	—2.4	—1.0	.190	—9.5	—8.9
	.75	.172	—7.0	.173	+.6	—6.5	.165	—4.2	—12.1
	1.0	.156	—7.7	.156	0	—7.6	.150	—3.9	—12.6
Glasser	0						.34		
	.25	.250	+1.2	.255	+2.0	+2.7	.224	—10.5	—10.3
	.5	.201	—4.5	.210	+4.5	+1.4	.193	—4.1	—7.3
	.75	.184	—.5	.185	+.5	0	.176	—4.3	—5.1
	1.0	.170	+.6	.170	0	+.6	.164	—3.5	—3.0

Note.—Groupings as follows: Columns 1, 2, and 3; Columns 4, 5, and 6; Columns 7, 8, and 9.

sions differ by 22.4 per cent (Column 5). In order to check Duane's curves, λ_e was calculated using Equations (2) and (3a), and the very good agreement is indicated in Column 7.

If the quality of a beam of unfiltered radiation is desired, we are confronted by the question of which one of the eight values in Table III is to be used. Obviously no one of the methods will give a correct value of λ_e, nor can we readily obtain the slope of the absorption curve with any degree of accuracy at zero filter. We must thus choose an arbitrary technic for making this measurement or else use some other method, such as the half value layer in copper or aluminum. Here, again, it will be found that only a standard ionization chamber will give accurate and reproducible results.

Table IV gives a further comparison of the three methods of determining the effective wave length of 133 K.V. filtered radiation, using for each filter the standard Friedrich and Glasser ionization chambers. Column 1 gives the filtration of the beam; Column 2, the "true effective wave length" obtained from the slope of the absorption curve; Column 4, the effective wave length by the bracket method with a filter separation of 0.25 mm., and Column 7, Duane's effective wave length, using an 0.25 mm. copper filter.

Column 3 gives the percentage difference between the true effective wave lengths obtained with two thimble chambers and the values obtained with the standard chamber. It is evident that the disagreement is somewhat random, although the values obtained with the Glasser chamber appear to agree better with those of the standard.

Column 5 gives the percentage difference between the effective wave lengths obtained when using the slope and bracket methods with each of the three chambers. Here we see that when using the standard chamber the two methods agree very closely, whereas for the thimble chambers the agreement is not so good. It is also seen that for high filtrations the two methods agree well within the experimental error.

Column 8 gives the percentage difference between Duane's and the true effective wave length as measured with the standard and thimble chambers. As expected from Section II, the differences are large for all filtrations, although they become less for increasing filtration.

It must be emphasized again that, for much of the medical work done, the differences in effective wave lengths due to the use of thimble chambers is of no great importance. The fundamental difference between the three methods described is, however, of sufficient magnitude to be taken into consideration for all types of work.

Table V summarizes a series of absorption measurements made by Failla for the same radiation, but using six different types of ionization chamber. Columns 2 to 7 give the true effective wave lengths for the initial filtrations given in Column 1.

From the discussion above we see that, while Duane's effective wave lengths are not the closest to the true effective wave length, they are the simplest to determine, requiring but one intensity measurement besides that of the original beam. The bracket method is considerably closer, but requires two extra intensity measurements. In both of these methods the accuracy of the measurement is dependent upon the filter thickness, as stressed by Duane, who recommends the use of the mass per square centimeter of the filter instead of its thickness, the former being much easier to measure accurately. To obtain the "true effective wave length," of course, requires a series of intensity measurements, and consequently is not so applicable in practice as the other two methods.

For reference, curves are given showing λ_e as a function of the percentage transmission of the filter (Fig. 6). These are identical with Duane's curves and may be used in determining λ_e by his method. In applying these curves to the bracket method it must be clearly understood that the intensity measurements are made for filter thicknesses equally above and below the filter used in practice.

IV. RECOMMENDATIONS ON THE PROCEDURE FOR QUALITY EXPRESSION

In the foregoing discussion it has been shown that a large number of methods of quality expression have been proposed and used. For example, in the work of Burby and Barry, and Pohle and Barnes,[36] we find some half-dozen methods of determining the effective wave length, although the authors have carefully explained the use of each method. Likewise, Quimby[37] used several kinds of λ_e in addition to the absorption coefficient of the radiation to express quality —with proper explanation in each case. As shown in (III, 3, (b)), it is impossible to readily correlate effective wave lengths when obtained with different filter thicknesses.

In all the methods for obtaining λ_e, two steps are involved—determining an absorp-

[36] See Footnotes 5 and 7.
[37] William Duane, Am. Jour. Roentgenol., 1922, IX, 167.

TABLE V

Filter	Standard λ_e	Drum λ_e	Bakelite λ_e	Graphite sphere λ_e	Aluminum mesh λ_e	Aluminum sphere λ_e
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mm.	*Å.*	*Å.*	*Å.*	*Å.*	*Å.*	*Å.*
0.25	0.256	0.244	0.261	0.246	0.247	0.264
.50	.192	.193	.187	.201	.185	.212
.75	.177	.177	.171	.178	.181	.192
1.00	.164	.165	.160	.165	.170	.179

tion coefficient μ of the radiation by some means and from this the wave length of monochromatic radiation having the same μ. For certain ranges Pohle and Barnes found that Duane's effective wave length curves were inadequate, and consequently expressed λ_e in terms of the percentage transmission of a given filter—a physically undesirable procedure. The fact remains that at present the monochromatic wave length copper absorption coefficients have not been determined over the full range needed to determine λ_e for all the radiations used in X-ray therapy.

It seems reasonable, therefore, to recommend that the absorption coefficient in copper or aluminum of a heterogeneous beam of X-rays be used alone to express the quality, stating the methods used in its determination. If desired at any future time, it is then a simple matter to express from available data the effective wave length in the

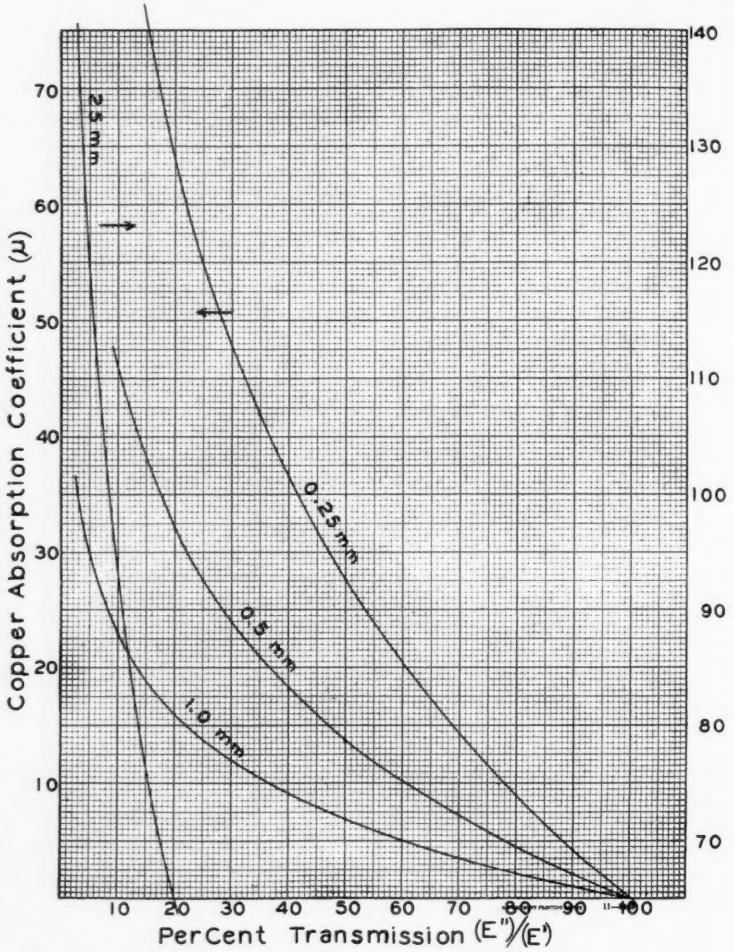


Fig. 7. Copper absorption coefficients as a function of the percentage transmission through given filters of finite thickness.
Note that the curve for 0.25 mm. filter is in two parts.

ranges where possible. Such a method would, for example, eliminate any confusion in Pohle and Barnes' tables.

As shown in (II, 1), the most accurate value of the composite absorption coefficient is obtained when using an infinitesimal filter thickness. The degree of agreement between this and one of the finite filter methods has been shown in Table II.

In practice, μ may be determined (1) directly from the slope of the copper absorption curve, giving the true absorption coefficient; (2) by Duane's method, giving an approximate absorption coefficient, and (3) by the bracket method, giving a value in closer agreement with the true absorption coefficient. The first requires a series of measurements. The second and third require but two measurements and μ is calculated from Equation (10).

For reference, Figure 7 gives curves for the absorption coefficient as a function of the percentage transmission of several thicknesses of filter which may be used in applying Methods 2 and 3, above. These apply for a filter of any material but care must be taken that the material and thickness are always specified.

V. SPECTRAL ENERGY DISTRIBUTION AS DERIVED FROM COPPER ABSORPTION MEASUREMENTS

We may now turn to one other application of the foregoing copper absorption measurements, namely, the determination of a qualitative picture of the energy distribution in a beam of filtered heterogeneous radiation without the use of a spectrometer.

The effect on an X-ray beam of adding successive layers of a filtering material (copper, for example) is to reduce the intensity of all incident wave lengths according to the absorption law expressed in Equations (3) and (3a). As seen from this equation, the greatest absorption occurs in the longer wave lengths, so that by increasing the filter thickness the energy becomes relatively more and more concentrated in the shorter, more penetrating wave lengths.

If, to take a particular case as an example, a tungsten target X-ray tube be operated below the critical voltage (70 K.V.) at which the characteristic K series of lines appear, the effect of increased filtration is such that the maximum of the spectral energy distribution curve of the filtered radiation shifts steadily toward shorter wave lengths. It would be expected that for such conditions a logarithmic plot would approach asymptotically a straight line, the slope of which is the μ for the short wave length limit. Since this would require that the remaining energy be practically zero, we would not expect the absorption curve to become straight for filtrations ordinarily used (0 to 3 mm. copper).

However, in the case of operating the same tube well above its critical voltage, for example, at 150 to 200 K.V., the K lines will be present and conditions altered. The effect now of increased filtration is again to reduce the energy at all wave lengths, the resulting energy distribution being dependent upon the voltage and filtration; but, in general, the energy transmitted through thick copper filters will consist of several practically monochromatic lines—the several K lines and the "end" radiation at the short wave length limit.

At present we have no very accurate data concerning the relative intensity of the K_α lines in comparison with the continuous spectrum background. There will always be present a certain amount of this radiation of shorter and less easily absorbed wave lengths, and it is thus impossible to state in advance the expected form of the logarithmic copper absorption curves for such radiation after high filtration. Only if the amount of continuous radiation were negligible, compared with that of the line radiation, could it be expected that the absorption curve would become straight, thus indicat-

ing a constant absorption coefficient μ. At tube potentials of the order of 150 K.V. it has been tacitly assumed by some workers that a large part of the spectral energy comes from the Kα lines of tungsten which appear at wave lengths of about 0.2 Å., thus accounting for a straight end to the absorption curve. However, such a distribution of energy, even in highly filtered radiation, is contrary to experience.

Having obtained values of λ_e for copper filtrations up to 3 mm. we see that the effective wave length of 130 K.V. radiation does not approach the wave lengths of the tungsten $K\alpha$ lines which occur at about 0.208, 0.213, 0.184, and 0.179 Å., respectively. The nearest approach of λ_e to these wave lengths occurs for about 0.6 to 0.8 mm. of copper filter; whereas, for the maximum filtration used, λ_e was about 0.134 Ångström. This is a reasonable value of λ_e, since for the voltage used the minimum wave length λ_o of the spectrum is 0.095 Ångström. The fact that $\lambda_e = 0.134$ Å. is nearer $\lambda_o = 0.095$ Å. than the wave length of the K lines gives further indication that the larger part of the energy passing through the filter is not that of the K lines, but that of the continuous spectrum background instead.

As a qualitative check of the above reasoning, we may refer to some approximate spectral energy distribution curves obtained by Duane[38] with an ionization spectrometer. The curve shown was made at 161 K.V. (constant potential) and 1 mm. of copper, and it is shown thereby that the greater part of the remaining energy apparently lies at shorter wave lengths than the first-order tungsten lines.

VI. SUMMARY

1. A qualitative theory of copper absorption measurements shows that, for a known spectral energy distribution, an effective wave length may be determined which is definitely related through known absorption laws to that distribution.

2. The logarithmic copper absorption curves for heterogeneous high voltage X-radiation do not become straight for filtrations up to 3 mm. copper when the measurements are made with a standard ionization chamber.

3. Absorption measurements, applied to the problem of describing the quality of a heterogeneous beam of X-rays, show (*a*) that measurements of the so-called "average wave length" of the radiation have no meaning as long as they are based strictly on the logarithmic absorption curve becoming straight for filtrations greater than the "homogeneity filter"; (*b*) the "half value layer" method of expressing quality is sensitive at least up to 1.6 mm. copper filtration but is readily reproducible only for strictly constant voltage applied to the X-ray tube; (*c*) the most logical expression of the "effective wave length" is obtained when using the absorption coefficient given by the slope of the logarithmic absorption curve. This is called the true effective wave length.

4. Duane's method for obtaining the effective wave length gives values consistently lower than the true effective wave length, although the difference is not great enough at higher filtrations to have any significance for most medical work. If this method is employed, the thickness of copper used in the measurement should be stated.

5. The bracket method for determining the effective wave length is more accurate than any other approximate method, but requires one more observation than the Duane method.

6. Absorption measurements made with the more common form of thimble ionization chamber are subject to error due to the chamber "wall effect." Such error is minimized in the true effective wave length method.

7. The absorption coefficient obtained with a standard thickness of copper (or alu-

minum) is recommended as the simplest general method of describing the quality of a heterogeneous beam of X-rays for therapeutic uses. Due to a lack of monochromatic wave length absorption data over a sufficient range, it is impossible to extend the effective wave length method over the whole range of radiations encountered in X-ray therapy. Thus, for a perfectly general physical definition of quality, the "true" absorption coefficient obtained from the slope of the absorption curve is recommended.

8. The effect on heterogeneous tungsten radiation of increasing the copper filtration is the concentration of the major part of the transmitted energy in wave lengths shorter than the K series of lines.

Recognition is due G. Singer, of this Laboratory, for having carried out the experimental part of this work.

COLOR CHANGES PRODUCED BY ROENTGEN RAYS IN SOME AQUEOUS SOLUTIONS

CONSIDERED FOR DOSAGE MEASUREMENTS AND FOR DETECTION OF EFFECTS OF RADIATION ON OTHER CHEMICAL COMPOUNDS

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CHEMICAL effects produced by roentgen radiation have been studied during the past years by several investigators. Changes have been produced in a number of compounds, as has been pointed out in a recent article by Clark and Pickett (1). As a rule, very minute quantities are changed chemically by the roentgen dose which can be applied in a reasonable length of time. It is, therefore, not surprising that some of the substances irradiated seem to have been unaffected. Whether no change at all took place, or whether the methods for detecting the change were not delicate enough, remains to be determined. The studies to be described here may lead to a delicate method for detecting chemical effects of the radiation and a method which may perhaps be applied to a great number of substances.

Our investigations were at first aimed mainly at finding a simple method for measuring roentgen-ray dosage. Considering that some color change might be found that would be satisfactory for this purpose, we started to investigate the effect of radiation on solutions of a number of chromatic substances.

Color changes produced by roentgen rays have long been utilized as a means of measuring radiation quantitatively. The Sabouraud-Noiré (2) dosimeter is based on this principle. Solids of fairly high average or effective atomic weights are used in this as well as in other similar dosimeters. Aqueous solutions should be better for two reasons: *(a)* water absorbs and scatters roentgen rays to about the same extent as tissues, and *(b)* the color change in solutions can be measured accurately by means of colorimeters, or, still better, by spectrophotometers.

Fricke and Morse (3) have described how the oxidation of ferrous sulphate in a 0.8 N sulphuric acid solution can be used for measuring dosage, and we have used this method to find out how much roentgen radiation was absorbed in the different solutions we examined. The main practical objection to this method is that the amount of $FeSO_4$ oxidized has to be determined in a rather complicated way. Recently Wyckoff and Baker (4) have found that the action of roentgen rays on Eder's solution [$HgCl_2$ $(NH_4)_2$ $C_2O_4 \rightarrow HgCl$] may be utilized for measurements of dosage. It is, however, rather questionable whether this method can be made practical, though attempts in this direction have been made (5).

Fricke found that the amount of $FeSO_4$ oxidized per cubic centimeter of solution was directly proportional to the dose, and independent of the concentration. The same relation was found by Clark and Pickett (1) to hold for the reduction of potassium nitrate to nitrite. We have obtained similar relations for tyrosine (5) and phenol. As very small amounts are changed it is evident that at least for certain compounds it is best and often necessary to use very dilute solutions in order that it may be possible to measure the effect of the radiation. We consequently used only substances which gave a strong color in weak solutions.

After some experimentation we decided that it was of advantage to use a tube 10 cm. long for the measurements of the color change, and that the solution in such a tube

should have a decided and easily measurable absorption band in the visible part of the spectrum before it was irradiated. The concentration for each substance had to be regulated to suit these conditions. The following were selected for a test: methylene blue, potassium dichromate, potassium permanganate, gentian violet, acid fuchsin, ferric ammonium citrate 1 per cent, cupric nitrate 1 per cent, nickelous chloride 1 per cent, and cobaltous chloride 1 per cent. The last four of these compounds had to be used in comparatively concentrated solutions and (probably as a consequence) showed no appreciable change after one hour of irradiation. Mercurochrome, erythrosine, and eosine did not seem to be especially influenced either. Gentian violet showed a definite decrease in absorption after irradiation (1 c.c. saturated ethyl alcohol solution in 10 liters H_2O), but not as much as methylene blue. Acid fuchsin showed a decided reduction of the absorption band between 460 and 580 mμ. It also did not change as decidedly as a 0.00016 per cent aqueous solution of methylene blue, which will be considered in greater detail later. Neither did potassium dichromate prove to be as sensitive. Potassium permanganate in a 0.001 N solution was very sensitive to radiation. It is the only one of the substances discussed here which showed a decided increase in absorption. Unfortunately, it is unstable in this concentration even when kept in the dark. It was studied rather thoroughly and shall, therefore, be mentioned again.

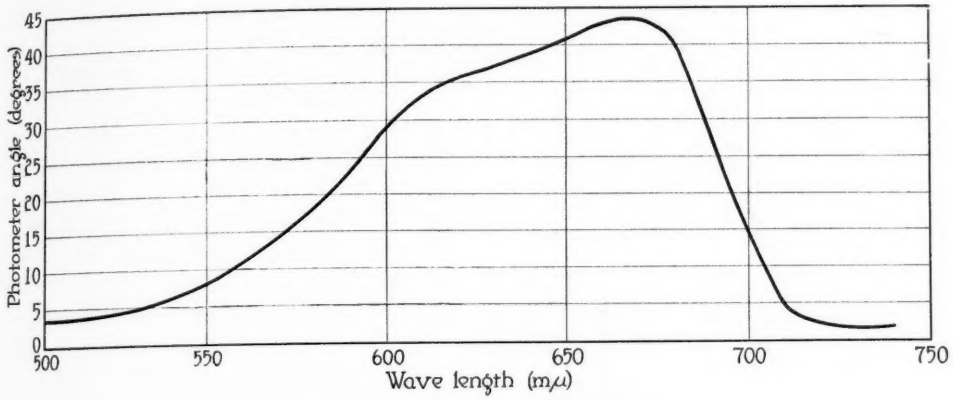


Fig. 1. Absorption curve for methylene blue.

Before the results are discussed further it seems advisable to describe how the experiments were carried out. Radiation given off from a high voltage therapy tube was utilized while patients were being treated. The solutions were placed in specially made glass tubes. For some of the experiments the tubes were sealed off by a flame after about 20 c.c. of the solution had been poured in. These tubes measured 1.5 to 1.7 cm., inside diameter, and about 15 cm. in length, with a wall thickness of about 0.13 centimeter. For other experiments 50 c.c. of the solution were poured into glass tubes equipped with ground glass stoppers. These tubes measured 17–19 cm. in length, 2.3 cm. inside diameter, with a wall thickness of about 0.13 centimeter. For most of the experiments the glass was painted black so that no light could reach the solutions. The glass tubes were placed inside the container in which the roentgen tube was housed (an Acme-International tube stand), at a distance of about 60 cm. from the center of the

tube to the target. They were laid down all in the same position with the top away from the target and 1 cm. higher than the bottom. Usually one of the tubes was kept in a lead capsule and served as a control. In order to determine the amount of roentgen radiation absorbed by a weak solution in such glass containers per hour of radiation, some of them were filled with 0.001 N $FeSO_4$ in 0.8 N H_2SO_4. The dose absorbed was measured in a manner similar to the one used by Morse and Fricke (3), using the value of 0.0027 mg. $FeSO_4$ per c.c. oxidized by one kilo roentgen, which value was calculated from their data. Two hundred K.V., 30 ma., and no filter except the glass wall of the container were used. About 8 kilo roentgens were thus found to be the dose given the solution per hour. Independently of the absolute dose, this method gives a good comparison between the oxidation effect on $FeSO_4$ and the other effects studied.

In order to determine quantitatively the light absorption of the solutions, a Bausch & Lomb spectrophotometer was used, consisting of a constant deviation spectrometer and a Marten's polarization photometer. An unirradiated sample of the solution was always measured immediately before or after the measurements were taken of a sample of the same solution which had been exposed to roentgen rays.

A 0.0002 molar solution of $KMnO_4$ is strongly colored purple. It has a wide absorption band in the yellow, green, and blue, with a maximum at about 530 mμ. The band is so intense that it seemed quite black between 510 and 560 mμ when a 10 cm. absorption tube was used. A 5 cm. tube permitted fair readings and was, therefore, used instead for this particular solution. An exposure of 15 minutes to roentgen rays showed a decided effect, in that the absorption below 500 mμ increased to an extent that was easily measurable. The absorption towards longer wave lengths remained practically unchanged, however. The increased absorption toward shorter wave lengths is due to a formation of MnO_2 (7). This was the most sensitive reaction we found but it did not seem practical to use it, as the $KMnO_4$ in such a weak solution is so unstable that it is changed to some extent even when kept in the dark.

Of all the substances tried, methylene blue seemed to be the most promising. It was used in different concentrations, and, of these, 0.0016 mg. per c.c. was the most favorable one when used in a 10 cm. absorption tube. Figure 1 gives the light absorption curve of this solution when the wave length measured in mμ is used as abscissa and the angle of the photometer is used as ordinate, 45° being complete absorption, and 0° no absorption. When the solution was irradiated the absorption was gradually reduced, but the shape of the curve was retained except in the green region of the spectrum. It seemed, therefore, unnecessary to take measurements at more than two or three wave lengths and it was decided to measure the amount of absorption quantitatively at 665, 620, and 520 mμ. The percentage of methylene blue disappearing (as indicated by the color) can be calculated by means of the formula,

$$\frac{C_1}{C_2} = \frac{\log T_2}{\log T_1};$$

where C_1 and C_2 refer to the concentration before and after irradiation, respectively, and T_1 and T_2 to the corresponding transmission. $T = \tan \Theta_1 \times \cot\Theta_2$; where Θ_1 refers to the angle of the polarization photometer between 0° and 45° and Θ_2 the angle between 45° and 90° that gives a good match. ($T = \frac{I'}{I}$ where I = intensity of incident light; I′ intensity after passing through the solution.) Table I gives the relation between the amount of radiation and the color change of two independent experiments. Column 1 gives the time of exposure to roentgen radiation; Columns 2, 3, and 4 the reading of the photometer for

TABLE I.—METHYLENE BLUE

Time of exposure	Photometric readings			Unchanged		
(hrs.)	at 520	620	665 mμ	%	(mg. per c.c.)	Log %
0.00	41.1	9.2	1.4	100	0.0016	2.00
0.38	40.7	11.8	3.1	79	0.00126	1.90
0.79	39.4	13.6	5.3	64	0.00102	1.81
1.31	38.7	18.3	10.7	45	0.00088	1.65
1.78	39.4	24.1	18.6	29	0.00046	1.46
2.21	39.8	26.2	20.6	27	0.00043	1.43
2.79	40.7	30.7	28.0	17	0.00027	1.23
0.00	41.7	10.2	1.8	100	0.0016	2.00
0.59	40.5	14.6	5.3	69	0.00110	1.84
1.02	40.1	18.8	10.2	50	0.00080	1.70
1.48	40.0	24.4	17.9	33	0.00053	1.52
2.07	40.1	28.6	24.8	22	0.00035	1.34
2.64	39.0	28.6	25.8	20	0.00032	1.30
3.17	40.5	37.6	38.6	7	0.00011	0.85
4.15	41.0	37.8	40.3	5	0.00008	0.70

wave lengths 520, 620, and 665 mμ, respectively; Column 5 the percentage of change calculated from the absorption at 665 mμ; Column 6 the concentration of the solution according to the color in mg. per c.c., and Column 7 the logarithm of the percentage of unchanged methylene blue. The percentage of change as a function of the time of exposure is shown graphically in Figure 2-*A*, which is drawn by inspection. It is evident from the curve that the change is not directly proportional to the dosage as is the case with $FeSO_4$. If the logarithm of the percentage of methylene blue unchanged is plotted against the time of exposure the relation seems to be a straight line (Fig. 2-*B*) as far as the accuracy of the readings permit us to conclude. This is, of course, only a first approximation. This is the same type of relationship that has already been found to hold for the deactivation of trypsin (8) and for the oxidation of oxyhemoglobin to methemoglobin (9). We believe this is due to the formation of substances with little or no light absorption in the measured region, which are decomposed further by the roentgen radiation, thus competing with the methylene blue for the ions produced by the radiation in the water. The stability of the methylene blue solutions was tested in that samples of the solutions were left standing for one week and then examined again with the spectrophotometer. The samples which had been exposed to the light in the meantime showed slightly diminished absorption, whereas samples which had been kept in the dark showed no change after one week. Thus the methylene blue seemed both stable enough and sensitive enough to be used for measurements of roentgen dosage. This conclusion was contradicted by further experiments, which will be mentioned later. It was objectionable to use a glass container if radiations of different hardness were to be compared with one another.

In trying to find material for suitable containers we decided that kodaloid[1] offered several advantages. Cylindrical containers were made by rolling the material around a rod, dissolving and softening the edges with acetone, and sealing on the bottom piece in the same manner. After the containers were dry the solution was poured in and a cover sealed on. When the solution was irradiated in these containers the change was less than one-half of what it had been in the glass tubes. It seemed possible that a small amount of the acetone had been brought into the solution and that the acetone in competition with the methylene blue had utilized part of the energy supplied by the roentgen rays. A drop of acetone was, therefore, added to the solution in one glass tube and that tube irradiated at the same time as a solution free from acetone. The effect on the methylene blue in the latter solution was several times greater than on that in the former, indicating that the effect of the roentgen radiation had been utilized mainly by the acetone. The acetone did not change the color before irradiation of the solution. This experiment indicated that a very small organic impurity may change the effect on the substance which is being tested, especially

[1]This is a cellulose product which can be obtained in sheets from the Eastman Kodak Company. It is an organic material with about the same absorption and scattering coefficient as water and it can be obtained in very uniform thickness.

when weak solutions are used. It was also a warning that special precautions have to be taken if such solutions are going to be used for measurements of dosage. (If a number of glass tubes, which have been cleaned together, are filled with parts of the same solution at the same time, one can, however, be reasonably sure that they can be used for comparison of dosage.) The effect of a small amount of acetone in the methylene blue solution undoubtedly explains why Clark and Pickett failed to get any decomposition of methylene blue dissolved in acetone.

The fact that very small amounts of substances influenced by roentgen irradiation reduce the change of the methylene blue makes such solutions sensitive indicators to test, whether the added substance is affected by the radiation or not. It seems that the method might be worked out for quantitative determinations.

Some preliminary experiments were carried out with ethyl alcohol, sucrose, $CaCl_2$, and phenol as added impurities. The results are summarized in Table II. Each glass tube contained 0.0016 mg. methylene blue and 0.02 mg. of added substance per c.c. of solution.

The figures in the same horizontal lines refer to tubes irradiated together for the same length of time. $CaCl_2$ does not influence the amount of change, whereas ethyl alcohol and sucrose reduce the change of methylene blue to about the same extent. The quantitative relations have not been studied as yet, but it has been shown that if one-tenth as much of the substance is added as impurity, the influence of it is much more than one-tenth as great. It should be mentioned that it has been discovered before that sucrose and phenol in aqueous solutions are influenced by roentgen irradiation.

Another factor which has a decided influence upon the radiation effect is the hydrogen ion concentration of the solution. Unfortunately we cannot give the exact pH value for the solutions referred to in this article (the methylene blue solutions had a pH

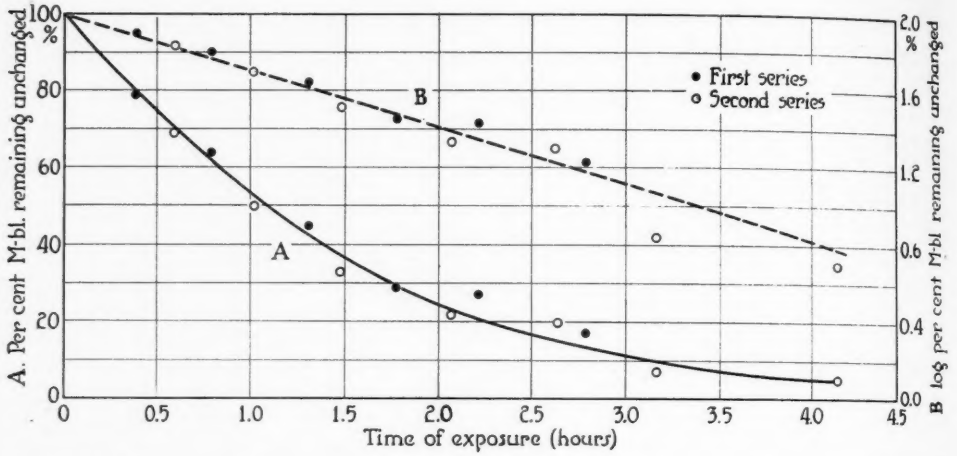


Fig. 2. *(A)* Decomposition of methylene blue. *(B)* Logarithmic curve of the decomposition of methylene blue.

TABLE II.—PERCENTAGE OF METHYLENE BLUE CHANGED

With no impurity %	With addition of 0.02 mg.			
	Alcohol %	Sucrose %	$CaCl_2$ %	Phenol %
51	19	17	51	
88				30
98				41

of about 7), but that will have to be determined in further experiments.

The investigation unfortunately had to be interrupted, but we hope to be able to continue the study later. It seems of special importance to point out that small amounts of impurities may have a decided influence on the action of roentgen rays on weak solutions, and, further, that such weak solutions of suitable compounds can be utilized for the indirect study of the effect of roentgen rays on other substances which cannot be measured accurately in such small quantities as usually are to be considered in experiments of this type.

SUMMARY

1. Several colored solutions have been irradiated by roentgen rays and the change of color has been measured by means of a spectrophotometer.

2. It was thought that a color change measured quantitatively might be used as a means to determine dosage. Of the substances which were affected to an appreciable extent, methylene blue seemed to be most suitable for this purpose, and was studied further.

3. A quantitative relation between the color change and the dose was obtained, but it was found that small impurities of organic substances disturbed this relationship. The hydrogen ion concentration also had a decided influence. Extreme precautions, therefore, have to be taken if such changes are going to be used for determination of dosage. This undoubtedly is true for whatever chemical method is being used.

4. The change of color produced by roentgen rays was not affected by calcium chloride but was definitely and to about the same extent influenced by small amounts of acetone, ethyl alcohol, sucrose, and phenol. Probably the effect of the radiation is divided between the methylene blue and the impurity, and it may be possible in this way to study the effect on the substance added to the colored solution. Such small amounts are, as a rule, changed by the radiation that for many substances it would be impossible to discover the effect of it by the direct method.

BIBLIOGRAPHY

(1) CLARK, GEORGE L., and PICKETT, LUCY W.: Jour. Am. Chem. Soc., February, 1930, LII, 465.

(2) SABOURAUD, R., and NOIRÉ, HENRI: Presse Med., 1904, XII, Pt. II, 825.

(3) FRICKE, HUGO, and MORSE, STERNE: Am. Jour. Roentgenol. and Rad. Ther., November, 1927, XVIII, 430.

(4) WYCKOFF, RALPH W. G., and BAKER, LILLIAN E.: Am. Jour. Roentgenol. and Rad. Ther., December, 1929, XXII, 551.

(5) QUIMBY, EDITH H., and DOWNES, HELEN R.: RADIOLOGY, May, 1930, XIV, 468.

(6) STENSTROM, WILHELM, and LOHMANN, ANNE: Jour. Biol. Chem., October, 1928, LXXIX, 673.

(7) RIDEAL, E. K., and NORRISH, R. G. W.: Proc. Roy. Soc. London, May 3, 1923, CIII, 342.

(8) CLARK, HARRY, and NORTHROP, JOHN H.: Jour. Gen. Physiol., Sept. 20, 1925, IX, 87.
ROTHSTEIN, KARL: Am. Jour. Roentgenol. and Rad. Ther., December, 1927, XVIII, 528.

(9) FRICKE, HUGO, and PETERSEN, B. W.: Am. Jour. Roentgenol. and Rad. Ther., June, 1927, XVII, 611.

ROENTGENOLOGIC CHANGES IN SARCOID AND RELATED LESIONS[1]

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THE disease known as Boeck's sarcoid is characterized primarily by the formation of nodules in the cutaneous and subcutaneous tissues. The skin over these areas has a telangiectatic appearance. The distribution of the lesions and the histologic picture are distinctive. Closely related to this lesion are the diseases known as Darier-Roussy sarcoid, lupus pernio, and erythema induratum. In this group of related diseases there are sometimes accompanying systemic complaints and more or less characteristic lesions in organs other than the skin. Among the systemic lesions that have been described are fibrocystic changes in the bones, infiltration in the lungs, adenopathy of the cervical lymph nodes, splenomegaly, tonsillar swelling, iritis, and infiltrations in the mucous membranes of the upper air passages.

Various hypotheses with regard to the etiology of this disease have been advanced: for example, that it is due to the bacillus of tuberculosis; that it is a separate disease entity, or that several factors are involved.

In certain cases the bacillus of tuberculosis has been isolated from the lesions in the skin, and definite tuberculous lesions have often been found. In other cases there is no evidence of tuberculosis and even the tuberculin test gives a negative reaction. The fact that a general lymphadenopathy sometimes occurs suggests the possibility that the condition is related to lymphoma. The favorable results reported in certain cases following roentgen-ray treatment would tend to substantiate this view. It is Voorhoeve's belief that, since the central nervous system is often involved, the lesions in the bones are of a trophic nature. He cited, to support this view, observations at necropsy in a case originally reported by Winkler in which there were definite changes in the nervous system.

Because of the fact that Boeck's sarcoid with visceral involvement is seldom fatal, pathologic descriptions of the visceral lesions are meager. Schaumann (13, 14) studied the bones histologically in cases in which the finger or toe had been amputated and reported that the findings strongly resembled those found in bones involved in lymphomatous processes. Hence he called sarcoid with visceral involvement "benign lymphogranuloma." The patient with sarcoid of the lung described by Bernstein, Konzlemann, and Sidlick (2) came to necropsy and lesions were found in the bronchial mucous membrane resembling sarcoid as it occurs in the skin.

The questions of etiology and the relation of the various types of sarcoid to one another are for the dermatologists to settle. Goeckerman (6) has given a very complete summary of the present opinion on these questions. It is, however, important for the roentgenologist to know that in the cases diagnosed as belonging to the sarcoid group there are roentgenologic signs which are more or less characteristic of the condition. These occur as changes in the bones and in the lungs.

CHANGES IN THE BONES

The first report of involvement of bone in cases of sarcoid lesions as noted by the roentgen ray apparently was that of Kreibich (8), who, in 1904, published a roentgenogram of the hands in a case of lupus

[1]Submitted for publication December 6, 1930.

pernio and gave a brief but accurate description of the roentgenologic data.

Rieder (11) reproduced the roentgenograms in two other cases and since then several European observers have reported cases.

Jüngling (7) described a condition of the bone to which he gave the name of "ostitis tuberculosa multiplex cystica," which was similar to the condition reported by the other writers in cases of sarcoid. Some of his cases were associated with sarcoid. Most of the changes in bone that he described were confined to the phalanges of the hands and feet, but in some the distal ends of the bones of the forearm were involved.

Fleischner (5) reviewed the roentgen-ray data in cases reported prior to 1924 and added seven new cases, in one of which a lumbar vertebra was affected by the sarcoid process.

In this country, Finnerud (4) reported a case and described typical roentgenograms but did not reproduce them.

Goeckerman (6) reported seventeen cases of sarcoid and in several cases reproduced the roentgenograms, showing changes in bone.

Doub and Menagh (3) recently described the roentgen-ray appearance of the bones in two cases that came under their observation.

Sarcoid with organic involvement is apparently a disease of adult life, for among the cases recorded in the literature the average age of thirty patients with sarcoid lesions of the lungs or bone was thirty-six years. Practically all patients were more than twenty years of age. Men and women were equally affected. The disease often has a fairly acute onset and later lapses into a chronic state. Lesions in bone tend to progress, but if the disease is arrested the appearance of the bones may return almost to normal. In other cases considerable permanent loss of bony tissue results.

The roentgenologic changes are usually

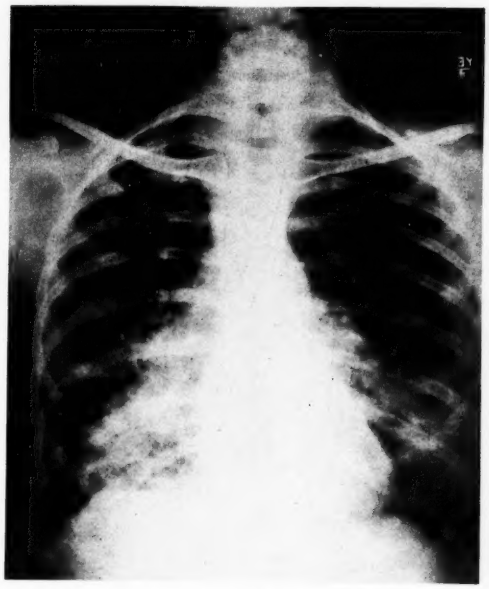


Fig. 1 (Case 1). Extremely dense, nodular infiltration in the lower portion of the right lung; moderate linear infiltration extending from left hilum.

in the phalanges of the hand, but the phalanges of the foot are frequently found to be affected. Changes in the lower ends of the radius and ulna, about the elbow joint and even in the body of a vertebra, have been described. The disease of the bone seems to be first evident as thickening of the trabecular architecture in the end of one of the phalanges of a finger. Small punched-out areas appear and later there is a peculiar combination of destruction and repair of bone. Clear cystic areas appear, varying from pin-point size to spaces 1 cm. in diameter. The small trabeculæ between the broken-down areas are dense and sclerotic. The whole phalanx may be affected. If the process is arrested and healing occurs, the bone may return almost to normal, but usually considerable mutilation results. No generalized atrophy of bone of the affected hand occurs, and but little localized atrophy of the diseased bone. Sequestration of the diseased part is absent and there is no ac-



Fig. 2 (Case 2). Fibrocystic areas in the second and third phalanges; middle finger of left hand.



Fig. 3 (Case 3). Multiple fibrocystic areas in many phalanges of both hands.

companying periostitis. The neighboring joints are not involved. The shaft of the affected bone may show slight uniform enlargement but the cortex is rarely broken.

Fleischner (5) and Doub and Menagh (3) described two types of roentgen-ray manifestations, according to whether the coarsening of the trabecular architecture or the areas of cystic destruction predominated. It appears likely that these are different stages of the same process. Such roentgenologic pictures must be distinguished from those seen in certain other diseases.

Tuberculous dactylitis, or spina ventosa, is seen mostly in the hands of children. Periostitis and atrophy of bone is marked. Sequestra and discharging sinuses are common.

Osteitis fibrosa cystica is seldom confined to the phalanges: it is more generalized and more progressive than the condition described. Fracture is more likely to occur.

Syphilitic disease of bone, particularly the congenital variety, sometimes affects the phalanges; the lesion is then more often in the diaphysis rather than in the head of the bone. There is some periostitis present and the cortex is thickened.

Malignancy can be ruled out by the multiplicity of the lesions and by the fact that the cortex is not broken.

Chondromatosis usually causes much more enlargement of the bone and definite tumors are seen.

CHANGES IN THE LUNGS

Kuznitzky and Bittorf, in 1915, gave a careful description of the changes in the lung in certain cases of sarcoid and reproduced roentgenograms in one case. They could not find evidence of tuberculosis in their case and were convinced that they were dealing with a disease *sui generis*. They subsequently observed seven cases in which they attributed changes in the lung to sarcoid.

Bernstein, Konzlemann, and Sidlick (2) reported a case which they considered to be sarcoid in which there was bilateral hydrothorax. The patient died and necropsy disclosed lesions with the histologic appearance of sarcoid in the bronchial mucous membrane.

Assmann in his text-book described the condition in the lungs and cited a case that came under his observation. The lesions in the lung in his case completely disappeared under roentgen-ray treatment.

Goeckerman (6) described the condition of the lung in several cases.

Valenti (16) stated that the pulmonary changes vary with the condition of the sarcoids in the skin. He reproduced roentgenograms taken three years apart which showed considerable improvement concomitant with improvement in the skin. These lesions differed from those described by others and from the cases that came under our observation in that the lesions were mostly in the upper half of the lungs.

Finnerud (4), Rischin (12), Lutz (10), Schinz (15), and Van Husen (17) also reported cases of sarcoid with more or less typical roentgen-ray manifestations in the lungs.

The roentgen-ray appearances that are seen typically in the lungs of these patients consist of bilateral, fairly dense, diffuse linear infiltration of the middle or the lower half of the lungs, extending from the hilum well out toward the periphery. This infiltration may be so dense as to obscure the borders of the heart. Superimposed on this are many discrete opaque areas, ranging in size from miliary nodules to areas perhaps 1 cm. in diameter. The apexes are not affected. Signs of pleurisy or fluid are absent. In some cases the nodes at the hilum are not enlarged and in others enlargement of these nodes is a feature of the roentgen-ray appearance. The picture in the individual case varies according to whether linear infiltrations or scattered nodules prevail.

The condition must be distinguished from other chronic conditions of the lungs. It has some of the characteristics of old fibrous tuberculosis but the apexes are not involved. Pneumoconiosis resembles it more closely, but in this condition the nodules are more definite and more numerous and there is not such a background of linear striations. Although the sarcoid lesions in the lung do not have a tendency to form cavities and are more diffuse than the usual type of bronchiectasis, yet it is often difficult to distinguish between the two conditions.

Cases of Boeck's sarcoid with visceral involvement are not common, and a roentgenologist will not be called on to make such a diagnosis from the roentgen-ray data alone. However, he should know that characteristic lesions may occur in the bones and in the lungs of such patients.

ABSTRACT OF ILLUSTRATIVE CASES

Cases 1 and 4 are illustrative of changes in the bones and in the lungs, Cases 2 and 3, of changes in the bones, and Cases 5 and 6, of changes in the lungs.

Case 1.—A woman, aged twenty-eight years, had had sarcoid lesions for seven years. Her general health was good. Roentgenograms of the lungs showed a peculiar infiltration of the bases (Fig. 1), while in the bones of the hands and feet were cystic changes. There were also atrophic rhinitis and enlarged lymph nodes. The spleen was palpable. A diagnosis of sarcoid was confirmed by biopsy. Bacilli of tuberculosis were not found in the sputum and the tuberculin test was negative.

Case 2.—A woman, aged forty-two years, had had typical sarcoid lesions for six years. Her general health was good except for iritis. The lungs were normal roentgenologically but fibrocystic changes were noted in the bones of the hands (Fig. 2). The diagnosis was confirmed by biopsy of the skin.

Case 3.—A woman, aged fifty-four years, in poor general health, had had sarcoid lesions for six years. Roentgenograms disclosed tuberculosis in the apexes of the lungs and infiltration of the lower part of each lung. Cystic changes were also noted in the bones of the hands and feet (Fig. 3). Active tuberculosis of the larynx was present. This patient died.

Case 4.—A man, aged forty-three years, had typical sarcoid lesions on both cheeks. He had also an enlarged spleen, enlarged

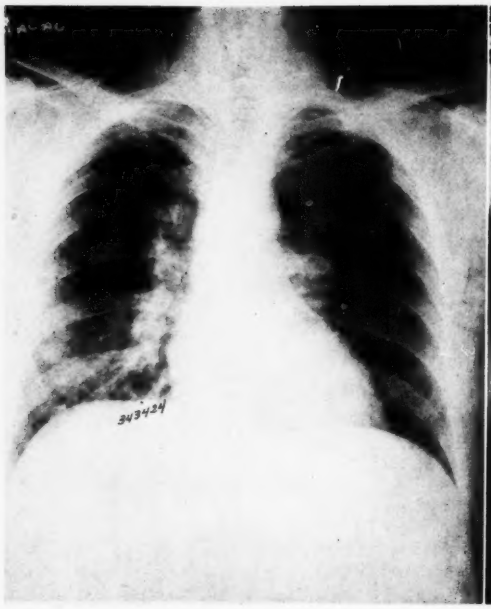


Fig. 4 (Case 4). Infiltration at the bases of both lungs, most pronounced on the right, with a large nodule, resembling malignant metastasis, in the right fifth interspace anteriorly.

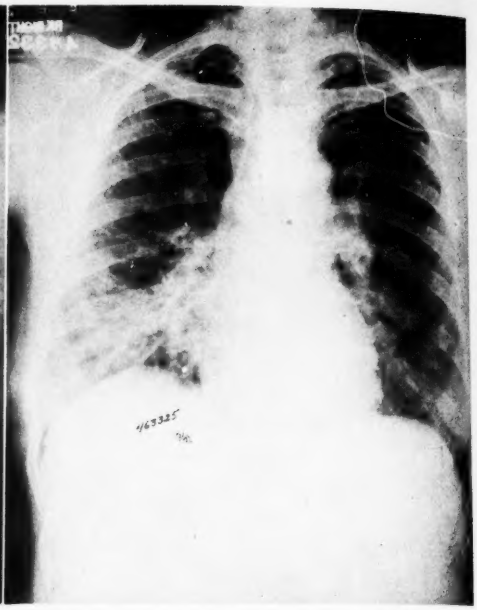


Fig. 5 (Case 5). Dense, diffuse infiltration in the lower portions of both lungs, most marked in the right lung.

lacrimal glands, and atrophic rhinitis. Roentgenograms of the thorax disclosed diffuse nodular infiltration suggesting metastasis (Fig. 4). Cystic areas in the phalanges of the hands were noted. The tuberculin test was negative. The diagnosis of sarcoid was substantiated by biopsy.

Case 5.—A woman, aged fifty-seven years, had sarcoid lesions on the cheeks and neck. She had also an enlarged spleen, and jaundice. Nodular infiltration of both lungs was revealed by the roentgen ray (Fig. 5). There were no changes in the bones. Biopsy from the skin confirmed the diagnosis of sarcoid.

Case 6.—A woman, aged thirty-nine years, had had sarcoid lesions for three years before coming to the Clinic. Her general health was fairly good. She complained of shortness of breath and "pleurisy pains." There was no history suggesting bronchiectasis. The Wassermann reaction of the blood was negative. Roentgenograms of the lungs disclosed extensive infiltration of the lower parts of both lungs (Fig. 6). Changes of bone were not found.

SUMMARY

When Boeck's sarcoid occurs with visceral involvement, characteristic changes may be observed in roentgenograms of the bones and of the lungs. The changes in the bones are manifested as punched-out cystic areas in the ends of the phalanges without any inflammatory reaction around them. The lungs show diffuse infiltration and mottling, usually in the lower or middle portion.

BIBLIOGRAPHY

1. Assmann, Herbert: Böck's Sarkoid. Die Klinische Röntgendiagnostik der Inneren Erkrankungen. Ed. 2. F. C. W. Vogel, Leipzig, 1924, pp. 301-302.
2. Bernstein, Mitchell, Konzlemann, F. W., and Sidlick, D. M.: Böck's Sarcoid. Arch. Int. Med., November, 1929, XLIV, 721.
3. Doub, H. P., and Menagh, F. R.: Bone Lesions in Sarcoid: Roentgen and Clinical Study. Am. Jour. Roentgenol. and Rad. Ther., February, 1929, XXI, 149.

4. FINNERUD, C. W.: A Clinical, Histological, and Bacteriological Study of a Case of Multiple Benign Sarcoid of Boeck-Darier-Roussy. Arch. Dermat. and Syph., September, 1921, IV, 342.
5. FLEISCHNER, FELIX: Die Erkrankung der Knochen bei Lupus pernio und Böck's Miliarlupoid. Fortsch. a. d. Geb. d. Röntgenstrahlen, 1924, XXXII, 193.
6. GOECKERMAN, W. H.: Sarcoids and Related Lesions. Arch. Dermat. and Syph., August, 1928, XVIII, 237.
7. JÜNGLING, OTTO: Ostitis tuberculosa multiplex cystica. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1919-1920, XXVII, 375.
8. KREIBICH, KARL: Ueber lupus pernio. Arch. f. Dermat. u. Syph., 1904, LXXI, 3.
9. KUZNITZKY, E., and BITTORF, A.: Boecksches Sarcoid mit Beteiligung innerer Organe. München. med. Wchnschr., October, 1915, II, 1349.
10. LUTZ, WILHELM: Zur Kenntnis des Boeckschen Miliarlupoids. Arch. f. Dermat. u. Syph., 1919, CXXVI, 947.
11. RIEDER, H.: Ueber Kombination von chronischer Osteomyelitis (Spina ventosa) mit Lupus pernio. Fortsch. a. d. Geb. d. Röntgenstrahlen, 1910, XV, 125.
12. RISCHIN, M.: Universelles benignes Miliarlupoid Böck mit Beteiligung innerer Organe. Arch. f. Dermat. u. Syph., March, 1922, CXXXIX, 30.
13. SCHAUMANN, JÖRGEN: Benign Lymphogranuloma and its Cutaneous Manifestations. British Jour. Dermat. and Syph., December, 1924, XXXVI, 515.
14. Idem: Etude sur le lupus pernio et ses rapports avec les sarcoids et la tuberculose. Ann. Dermat. et de Syph., 1916-1917, XLVI, 357.
15. SCHINZ, H. R.: Böcksches Sarcoid. Lehrbuch der Röntgendiagnostik. Ed. 2. G. Thieme, Leipzig, 1928, p. 633.
16. VALENTI, ALEXANDER: Sull'aspetto radiologico della lesioni polmonari nel sarcoide di Böck. Radiol. Med., September, 1928, XV, 942.
17. VAN HUSEN, JOHANN: Ein Beitrag zur Kenntnis des Boeckschen Miliarlupoids und seiner Beziehung zu Erkrankungen anderer Organe. Dermat. Ztschr., 1919, XXVIII, 1.
18. VOORHOEVE, N.: Ostite à kystes multiples et son Etiologie. Acta Radiol., 1923, II, 40.

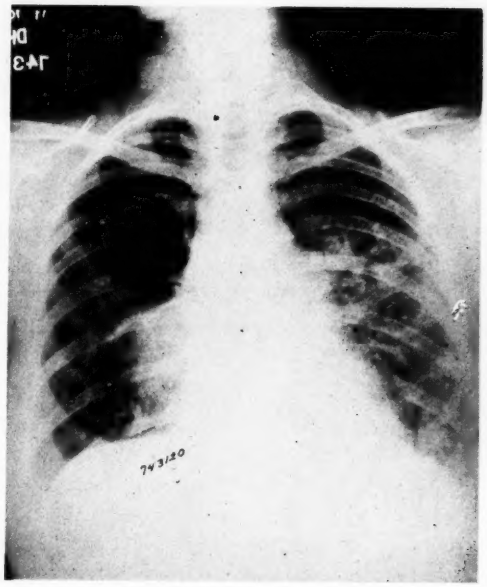


Fig. 6 (Case 6). Linear and nodular infiltration of the lower two-thirds of both lungs, most extensive on the left.

ANENCEPHALY; THE IMPORTANCE OF PRE-NATAL DIAGNOSIS, WITH REPORT OF CASE[1]

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AN anencephalon is a single monster, the greater part, or all, of whose brain is lacking. The bones of the vault are absent, the structures at the base of the skull are flattened, the eyeballs bulge, and the upper eyelids are unusually large. The shoulders are often larger than usual. The cervical vertebræ have an exaggerated lordosis, giving an extended appearance to the face and head resembling a frog's head.

DeLee (1) states that "single monsters are more frequent than double monsters, and, among the former, anencephalus ranks first." Muff (2) states that according to von Chaussier one monster appears in every 69 labors; von Puech, 1 in 111, and von Winckel, 1 in 64. This makes an average of 1 monster in 81 labors. Muff, in a survey of monsters at the various museums, found that there were nine times as many single monsters as double monsters. Ballantyne (3) in a series of 325 monsters and fetal disease cases had 46 anencephalic monsters (14 per cent). Case and Cooper (4) report 5 cases of anencephaly among 1,621 obstetrical cases at the Battle Creek Sanitarium, or 1 in every 324 labors (0.3 per cent). Mall (5) estimated the frequency of full-term monsters as 6 in every 1,000 labors. These figures indicate the rather frequent occurrence of monsters in general and of anencephalus in particular.

Williams (6), speaking of monsters, states: "The diagnosis of any one of these conditions is not made until serious difficulty, experienced in attempting delivery, has led to careful exploration under anesthesia, with the entire hand *in utero*."

In rare instances this condition has been diagnosed clinically. Pinzani (8) was able to recognize the presence of an anencephalon four days antepartum when he was able to detect cerebral contractions following irritation of the brain by the palpating finger. Others suspected, just before delivery, the presence of an anencephalon when the bulging eyeballs, prominent eyelids, and flattened sella turcica were recognized. Hydramnios, the anasarcous aspect of the patient, and thickening of the skin of the mons veneris and vicinity have been noted in cases of anencephaly.

Clinical diagnosis is admittedly very difficult. In the early months of pregnancy, vaginal, rectal, or abdominal palpation cannot detect a small deformed head. In the later months, a floating head, malpositions, and perhaps an accompanying hydramnios, leave the examiner confused as to the real situation. Although the presence of hydramnios, which is frequently associated with some fetal abnormality, might lead one to suspect the presence of an anencephalon, it cannot be relied upon as a pathognomonic symptom in individual cases. The incidence of anencephalus with hydramnios has been stated by several observers to be from 8 to 37 per cent. Lau (8) in 75 cases of hydramnios had 9 cases of monsters (12 per cent), 6 of which were anencephalic (8 per cent). He also reports 6 cases of anencephalus without hydramnios. Naujoks (7) had a case of anencephalon with oligohydramnios (500 to 600 c.c.). Eerland (8) had 30 cases of anencephalon, of which only 16 had hydramnios (52 per cent). This indicates the frequent but not constant occurrence of hydramnios with anencephalon. Hydramnios must also be differentiated from multiple pregnancies.

Dystocia is very frequent in these cases

[1]Read before the Bedford Medical Society, May 29, 1930.

because many of the anencephala develop to maturity and malpositions are common. Besides hydramnios, which is present in a large percentage of cases, cardiac and respiratory embarrassment and renal toxicosis frequently complicate the later months of pregnancy. Premature delivery is frequent. When pregnancy does go to term, dry labor is the rule; for the deformed fetal head, being unable to assist in the gradual dilation of the cervix, an early rupture of the membranes results. Abdominal section is not infrequent in unsuspected cases, and, to quote DeLee (1), "the humiliating experience of having a monster delivered after such an operation, has happened to clever accoucheurs." R. J. Maier reported a case of an anencephalon diagnosed pre-natally by X-ray but whose delivery necessitated a cesarean section.

All anencephalic fetuses are born dead or die very shortly after birth. Fetal mortality in all cases of hydramnios varies from 25 to 96 per cent, depending upon the acuteness of the fluid accumulation.

For these reasons it is apparent that when the presence of an anencephalon is suspected the fate of the fetus becomes a negligible factor and only the welfare of the mother should be considered. Anything which would aid in the establishment of an early diagnosis of anencephalon would save the mother the complications of a useless pregnancy going to term.

The roentgen ray has proven to be the only means of establishing such a diagnosis with certainty, pre-natally. Case, in 1916 (10), was the first to diagnose a case of anencephalon by the roentgen ray. Since then other cases have been reported by Campbell and Willits (11), Spangler (12), Doub (13), Rudolph (14), Blanchard (15), Richmond (16), Thompson (17), Andersen (18), Case and Cooper (4), Mooney (19), Maier (9), Harris (20), Jennings (21), Duca (22), Nessa (23), and Naujoks (7).

The causes of anencephaly have been ascribed to heredity, fetal injury *in utero,* poisons circulating in the maternal blood, chemical influence of the salts of sodium, potassium, lithium, and magnesium, syphilis, nutritional disorders, and endocrine disturbances. How these factors influence growth and why deformities of the head should be most frequent have been subjects of extensive investigation.

Normal growth is dependent upon the normal correlation of certain fixed physiologic laws. Any deviation from this normal correlation will result necessarily in abnormalities of development, which abnormalities will vary from minute, almost imperceptible deviations from the given type of growth to gross and grotesque variations, according as the disturbing factor has been slight or marked and has functioned early or late in the developmental period of the individual affected. The disturbing element is invariably the action of some extraneous force that has been brought to play upon the delicate regions of the most active growth of the embryonic organism. This extraneous force may be a congenital disease toxin, as of syphilis; a traumatism affecting the ovum in part or as a whole, or some mechanical, actinic, or chemical influence functioning from without the maternal body. If the disturbing force is the same, of the same degree of potency, and is applied at the same stage and point of developmental growth, the same type of monstrous defect will result. These are the general laws of teratogenesis.

There are two main theories that have been advanced in the explanation of the development of monsters, namely, the inhibitory and blastolytic.

Many monsters have been produced experimentally. Chemicals, changes in temperature, X-rays (24) and other agents have been used to influence the growth of embryos. The same type of monstrosity can be repeatedly produced by applying the same



Fig. 1. Roentgenogram of the mother in the lateral prone position showing the full fetal skeleton in the antero-posterior plane. The presentation is cephalic and the head rides above the mother's iliac crests. The facial bones minus the cranial bones give the appearance of a "cat's face." The spina bifida may be recognized by the cleft in the dorsal vertebræ.

agent at the same stage of development. If the agent is applied to only a part of the embryo, that part alone will be affected. This points to an inhibition or arrest in growth. The experiments of Child (25) and Stockard (26) support this theory.

According to Werber (27), who enunciated the blastolytic theory, monsters are due to the discharge, expulsion, or splitting of the germ substance. In consequence of the destructive action, a lens, for instance, may be found free in the head region of the early embryo even though eyes are entirely lacking; or there may be a complete absence of the spinal cord in its normal position, in which case it may be found in another portion of the embryo or may even be double. For these reasons Werber includes in his theory a force which tends to dissociate parts of the distal embryonic primordium. Other workers, however, have held that blastolysis is the effect rather than the cause of retardation of growth.

Greenhill (28) and Talbot (29) have called attention to the frequent association of placental defects and anomalies, especially placenta prævia, with deformities of the fetus. Greenhill records 21 such cases. He attributes the defects in the fetus to an imperfect decidual reaction in the lower uterine segment, an abnormal seat for placental attachment and development, and regards it as a condition simulating the imperfect decidual reaction in tubal pregnancy. Disturbances in nutrition and oxygen supply may take place in placenta prævia just as readily as in tubal pregnancy, thereby producing monsters by inducing an arrest of the developmental rate. Talbot believes that placental infarcts are the cause of the circulatory interference within the placenta. The frequency of cranial and intracranial defects in these cases is due undoubtedly to the fact that the central nervous system which received the main portion of the placental circulation is naturally the first portion of the fetal structure to suffer from the vitiated blood current, so, in consequence, a retardation of development results. The head differentiates first and grows most rapidly and therefore is most susceptible to deleterious influences. Anencephalus, he believes, is produced in the beginning of the fourth week of fetal life.

To determine the influence of endocrines in the production of anencephaly, Covell (30) made an exhaustive study of the hypophysis in 37 cases of anencephaly. He found it present in all cases, contrary to the findings of some previous investigators. It was flatter and its anterior lobe was larger than the hypophysis in normal fetuses; but after correcting for the blood content of the gland, he found that the hypophysis was quantitatively smaller than normal in every case of anencephalon. The normal gland has three lobes and a pars tuberalis. The latter



Fig. 2. Photograph of the anencephalic monster after delivery. Note the macerated skin, bulging eyelids, and absence of forehead.



Fig. 3. Dorsal view of the same fetus showing extensive spina bifida. Note the very short and thick neck.

lobe was absent in all cases he studied, although some other lobes were missing in some of the cases.

CASE REPORT

Mrs. O. J., 34-year-old primipara, was referred for roentgen examination on January 5, 1929, in the eighth month of her pregnancy. She was dyspneic and her abdomen was unusually large. Her pregnancy had been normal up to six and a half months, after which time the abdomen began to increase rapidly in size, the fetal parts became indistinguishable, and the fetal heart sounds (previously audible) were gradually lost. Her blood pressure gradually rose to 160 mm.; the blood Wassermann was negative.

Roentgen examination in the lateral prone posture showed the presence of a fetal skeleton of cephalic presentation and above the crest of the ilium. The bones of the face were distinctly visible but the cranial bones were absent. The thoracic vertebræ were unusually wide and there was a cleft in the middle of the column due to the absence of the spinous processes. The rest of the skeleton was apparently normal. A diagnosis of anencephalon with spina bifida was made and immediate interruption of pregnancy advised. Because of religious beliefs, the patient refused intervention.

In spite of treatment the abdomen became larger and the patient's blood pressure gradually rose to 190 millimeters. Four weeks later, February 4, 1929, the membranes ruptured and after eighteen hours in labor she was delivered of an anencephalon weighing 6¼ pounds. Four mild convulsions preceded the delivery. The postpartum period was uneventful. The fetus showed all of the characteristics of an encephalon. The entire vault was missing. The eyelids were un-

usually large, and there was a spina bifida extending from the base of the skull half way down the back. The skin in many places was macerated.

CONCLUSION

Cases of anencephaly and their resulting complications are of sufficient frequency to warrant greater accuracy in our diagnostic methods. Any pregnant woman giving a history of having previously given birth to a monster; one presenting an acute or unusual enlargement of the abdomen, or a fetal malposition or malposition of the placenta; one upon whom a cesarean section is contemplated, or one in whom the fetal head is not distinctly and apparently normal to the palpating fingers should have an X-ray examination of the abdomen. The cranial bones begin to ossify between the sixth and eighth week of fetal life and calcification is well advanced after the fourth month. Satisfactory roentgenograms can be obtained after the fourth month in a great majority of cases, but obviously the difficulty increases with the increase in the amount of amniotic fluid and the thickness of the abdominal wall. Practically all fetal skeletons are visible at the sixth month. Maternal complications rarely set in before the sixth month of pregnancy. Therefore, the optimum period for the roentgen examination of the pregnant abdomen is at about the sixth month of pregnancy. The small amount of X-ray energy utilized in modern technic is absolutely harmless to mother or fetus.

BIBLIOGRAPHY

(1) DeLee, Joseph B.: Principles and Practice of Obstetrics. W. B. Saunders Co., Philadelphia and London, 1916, p. 549.

(2) Muff, Walther: Ischiopagus tripus. Arbeit. a. d. Geb. d. Path., Anat. u. Bakteriol., 1911, VII, 589.

(3) Ballantyne, John W.: Manual of Antenatal Pathology and Hygiene: The Fetus. W. Green and Sons, Edinburgh, 1904, p. 332.

(4) Case, James T., and Cooper, John E.: The Early Diagnosis of Anencephalus. Surg., Gynec. and Obst., August, 1926, XLIII, 198.

(5) Mall, Franklin P.: On the Frequency of Localized Anomalies in Human Embryos and Infants at Birth. Am. Jour. Anat., July, 1917, XXII, 49.

(6) Williams, John W.: Obstetrics: A Textbook for Use of Students and Practitioners. D. Appleton and Co., New York and London, 1920, p. 859.

(7) Naujoks, H.: Röntgendiagnose der Anencephalie bei Hydramnion (Roentgen-ray Diagnosis of Anencephaly in Presence of Hydramnion). Zentralbl. f. Gynäk., July 21, 1928, LII, 1818.

(8) Pinzani: Cited by Naujoks.
Lau: Cited by Naujoks.
Eerland: Cited by Naujoks.

(9) Maier, R. J.: Anencephalus. Radiology, August, 1927, IX, 166.

(10) Case, James T.: Anencephaly Successfully Diagnosed before Birth. Surg., Gynec. and Obst., March, 1917, XXIV, 312.

(11) Campbell, A. M., and Willits, P. W.: Anencephaly: Monster: Diagnosis before Onset of Labor. Am. Jour. Obst. and Gynec., January, 1924, VII, 104.

(12) Spangler, D.: Value of Roentgen Ray in Diagnosis of Atypical Pregnancies, with Report of Two Cases of Anencephaly Diagnosed before Birth. Am. Jour. Roentgenol. and Rad. Ther., March, 1924, XI, 238.

(13) Doub, H. P.: Obstetrical Roentgenology, with Special Reference to Anencephaly. Am. Jour. Roentgenol. and Rad. Ther., July, 1925, XIV, 39.

(14) Rudolph, Louis: Roentgenographic Diagnosis of Anencephaly. Am. Jour. Obst. and Gynec., December, 1925, X, 840.

(15) Blanchard, L. H.: Anencephalic Monster. Jour. Am. Med. Assn., April 4, 1925, LXXXIV, 1041.

(16) Richmond, D. S.: Anencephalic Fetus. British Med. Jour., June 6, 1925, I, 1038.

(17) Thompson, O. R.: Anencephalic Monster. Jour. Med. Assn. Georgia, July, 1925, XIV, 283.

(18) Andersen, E. B.: X-ray in Prenatal Diagnosis of Fetal Monstrosity. Am. Jour. Obst. and Gynec., March, 1925, IX, 382.

(19) Mooney, Bernard R.: X-ray Diagnosis of Anencephalus. Canadian Med. Assn. Jour., September, 1927, XVII, 1053.

(20) Harris, A. Trevenning: Prenatal Diagnosis of Anencephaly with Spina Bifida. Am. Jour. Roentgenol. and Rad. Ther., September, 1929, XXII, 259.

(21) Jennings, C. H.: Case of Anencephaly. Am. Jour. Roentgenol. and Rad. Ther., April, 1929, XXI, 366.

(22) Duca, A.: Per la Diagnosi di Anencefalia Fetale in Gravidanza (Anencephaly, Diagnosed during Pregnancy). Clin. Ostet., March, 1929, XXXI, 130.

(23) Nessa, N. J.: Roentgenologic Diagnosis of Anencephalus. Radiology, January, 1929, XII, 66.

(24) Baldwin, W. M.: Artificial Production of Monsters, Demonstrating Localized Defects as Result of Injury from X-rays. Am. Jour. Physiol., June, 1920, LII, 296.

(25) Child, Charles M.: Physiological Foundations of Behavior. Henry Holt and Co., New York, 1924, p. 106.
Child, C. M., and McKie, E. V. M.: The

Central Nervous System in Teratophthalmic and Teratomorphic Forms of Planaria Dorotocephala. Biol. Bull., December, 1911, XXII, 39.

(26) STOCKARD, CHARLES R.: The Origin of Certain Types of Monsters. Am. Jour. Obst. and Dis. Women, April, 1909, LIX, 582.

(27) WERBER, E. I.: Experimental Studies on Origin of Monsters: An Etiology and Analysis of Morphogenesis of Monsters. Jour. Exper. Zoology, November, 1916, XXI, 485.

(28) GREENHILL, J. P.: Association of Fetal Monstrosities and Deformities, with Placenta Prævia. Surg., Gynec. and Obst., February, 1923, XXXVI, 227.

(29) TALBOT, J. E.: An Endeavor to Evaluate Chronic Sepsis in Pregnancy (Part I). Surg., Gynec. and Obst., July, 1922, XXXV, 42.

Idem: Part II. Surg., Gynec. and Obst., August, 1922, XXXV, 187.

Idem: Placental Infarct and its Relation to Etiology of Deformed Babies. Am. Jour. Obst. and Gynec., September, 1924, VIII, 271.

(30) COVELL, W. P.: A Quantitative Study of Hypophysis of Human Anencephalic Fetus. Am. Jour. Path., January, 1927, III, 17.

(31) DORLAND, W. A. N., and HUBENY, M. J.: The X-ray in Embryology and Obstetrics. Bruce Pub. Co., St. Paul, 1926.

THE TREATMENT OF WARTS[1]

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THE treatment of warts is a subject of widespread interest and demands a great deal of our time and consideration. It is common knowledge among dermatologists and other physicians examining large numbers of college students, both male and female, that the last ten years have seen a steady increase in the number of warts, particularly on the feet. This opinion is substantiated by the authors' statistics. We have examined and treated 765 patients with all types of warts within the past three years, equivalent to approximately from 5 to 6 per cent of the total number of cases seen in private practice. Prior to 1925, this figure did not exceed 3 per cent. Most of this increase in the incidence of warts has occurred in the class of plantar warts. The reasons for this are obvious. The wide popularity of all forms of sports requiring the common use of dressing rooms, shower baths, runways, etc., has increased the probability of infection. From our experience we are convinced of the infectious nature of ordinary verrucæ vulgaris, and verrucæ plantaris, which we feel are one and the same entity occurring upon different parts of the body. We feel that the work of Jadassohn (1), in 1896, and of Wile and Kingery (2), in 1919, has settled the infectious nature of warts with fair definiteness.

Table I shows the incidence of location in our 765 patients. It will be noted that our total number of patients with plantar warts outnumbers considerably the patients with warts on the hands. This, no doubt, is due to the fact that plantar warts produce symptoms whereas warts on the hands usually do not, and not to any actual increase in the number of plantar warts over the other type. Thirty-three patients presented warts on both the hands and feet, and 37 patients had warts both on the hands and face.

TABLE I.—INCIDENCE OF LOCATION OF WARTS

	No.	Per cent
Plantar	322	40.6
Hands	248	31.3
Face	149	18.7
Neck	22	2.8
Scalp	27	3.4
Arms and wrists	7	.9
Penis	5	.6
Miscellaneous (vulvæ, ears, perianal region, knee, chest, etc.)	12	1.6
Total	792	

As to age incidence, we have patients presenting warts of one form or another from the age of 8 months up to 81 years. By far the vast majority of patients were between the ages of 10 and 40, with the number about even in the second and third decades of life, and somewhat less in the fourth decade. Approximately 40 per cent were females, 60 per cent males.

THE TREATMENT OF PLANTAR WARTS

The treatment of plantar warts comprises one of the most important and difficult fields presented to the dermatologist and radiologist. The importance of plantar warts from an economic standpoint cannot be overemphasized. It is true that many plantar warts occasion no symptoms, but the vast majority of them cause symptoms ranging from pain and discomfort on walking, to actual confinement in bed.

The diagnosis of plantar warts usually does not occasion much difficulty; however, there is much to learn by careful clinical observation and study of each individual wart. It is easy enough to recognize a wart on the sole when it has reached the diameter

[1]Read before the Radiological Society of North America at the Fifteenth Annual Meeting, at Toronto, Ont., Canada, Dec. 2–6, 1929.

of a sixteenth of an inch, but frequently the small, pinhead-size satellite lesions are entirely overlooked. It is only by carefully paring down the area with a sharp razor blade that one can recognize these small lesions. The authors have found it advantageous to use a lens in the identification of these very minute, early warts. Calluses and corns are frequently mistaken for plantar warts; especially is this true of painful lesions occurring in the last interdigital space. These lesions occur more commonly in women than in men, and are located either at the base of the interdigital space between the fourth and fifth toes, or on the inner side of the small toe, and most frequently in both locations at the same time. Careful observation has convinced us that these lesions are usually not warts, but calluses produced by pressure. When the small toe is pressed inward by the pressure of a shoe, the inner surface of the small toe is pressed against the external or lateral tip of the fourth metatarsal bone. Spreading the toes apart and causing pressure on this point will produce the characteristic pain even when the calloused area is pushed aside and the pressure made through normal skin. We have never seen one of these lesions cured with X-ray or radium therapy, and we have seen a great many patients with such lesions made extremely miserable by this form of treatment. These lesions are best treated by changing the type of footwear, spreading the toes with a small soft cotton pad, and the application nightly of a mild keratolytic ointment. When the pressure is removed from the tip of the fourth metatarsal bone for a period of from six to ten weeks, the pain usually disappears.

Plantar warts vary in size from the minutest, which cannot be seen by the naked eye, to lesions as large as a 50-cent piece. Ordinarily, when recognized they are one-sixteenth to one-quarter of an inch in diamter. Satellites are frequently present, and search should always be made for them. The number varies from one lesion up to as many as three or four hundred on a foot. The wart is covered by a layer of keratotic material, the thickness depending upon the location, and proportional to the normal thickness of the horny layer of the part involved. On paring off the horny layer with a sharp razor blade, the translucent wart is seen embedded in the normal tissue. It may be larger or smaller, more frequently the latter, than it appeared before the horny layer was removed. After paring, brownish-black dots will be seen in the center of the wart. These are capillary loops which bleed profusely if cut. These brownish-black dots can always be seen except in the minutest wart, and, if bleeding occurs, it is a sign that the wart is still active and needs further treatment. The pain, of course, is the chief symptom of plantar warts. It may be totally absent in the case of a superficial, small lesion, but it may be so excruciating as to cause permanent disability for long periods of time. We have a number of patients who have been totally incapacitated, and confined to bed for periods of from six months to a year and a half on account of injudicious treatment, and a large number who have been partially incapacitated for long periods of time, with or without treatment.

We have gradually evolved what we feel is a thoroughly satisfactory technic for the treatment of plantar warts. It differs somewhat from the technic employed by others, including Michael (3), Taussig and Miller (4), MacKee (5), and Hazen (6). In the first place, we have practically discontinued the use of radium. The reasons for this are as follows:

1. The time required for the treatment of plantar warts with radium is considerably longer than that required for X-ray treatment.

2. When multiple warts are present, either a large amount of radium must be on hand, or else a number of separate applica-

tions with the same radium must be made on subsequent visits.

3. In spite of all the care possible, occasionally the patient will move his foot or contract his muscles in such a way as to disturb the lead foil and the radium. In this case a disagreeable result is apt to ensue, because the dose of radiation which would not produce any reaction when applied directly to the wart, will produce considerable reaction to the normal skin, and the patient is very quick to notice this.

4. Radium in plaque form with two thicknesses of rubber, with or without 0.5 mm. of aluminum, will produce considerably more reaction in the normal skin surrounding the wart than will approximately the same dose of X-ray. The authors have repeatedly demonstrated this fact to their own satisfaction, and it can readily be understood when one considers the difference in the distance from the source of radiation to the skin. With X-ray, one is dealing with parallel rays, practically speaking, while with radium applied closely to the skin, the radiation is spread out into the surrounding normal tissue, and the reaction ensues. We have treated one plantar wart with radium, and an adjacent wart on the same foot with approximately the same dose of X-ray. Reaction has occurred around the radium-treated wart, and the X-ray-treated wart showed no surrounding reaction.

Our technic for the treatment of plantar warts with X-ray is as follows:

1. The patient is placed on a high examining table, and the keratotic layer over the wart and for some distance around it is carefully pared down with a new razor blade, to a point just short of bleeding. We feel that careful attention to this one factor has increased our percentage of cures at least 20 per cent. Careful search should be made for small satellites which cannot be seen unless the keratotic layer is pared down, and these lesions should be treated at the same time.

2. After locating all of the lesions they are carefully outlined with a fine-pointed pen exactly at the periphery of the wart. Placing a sheet of thin oiled silk over the area on the foot, a careful tracing is made of the lesions. This tracing is then transferred to lead foil and the holes are cut out accurately with a sharp, fine scissors.

3. The patient is then placed on his abdomen or side, and the foot held in a stirrup which will not move, being so fastened as to give as much stability as possible to the entire leg. It is absolutely essential that the patient be under no muscular strain while the treatment is going on. The lead foil is then fitted exactly to the wart area, and fastened down by adhesive straps which go entirely around the foot. We feel that this is the most essential part of the entire process, and that the lead foil must fit exactly to the wart areas without exposing any normal tissue to the effect of the X-ray. We have found that nurses can be trained to do this work much better than doctors, and that they will take infinite pains to get the lead foil exactly in the right position. It requires time and patience on the part of the nurse, but the results justify the time. After instituting this procedure, we soon found that no reaction occurred in the normal tissue surrounding the wart, with our ordinary dosage of from 2 to 3 skin units of X-ray. We have gradually increased this dosage until we have reached 8 skin units, with absolutely no visible reaction in the normal tissue in a vast majority of cases, and only a slight erythema in those that did react. We have not had in the past three years, since following this technic, a single disagreeable reaction from X-ray.

4. In treating with X-ray, we have employed the following factors: 6-inch spark gap, 6 milliamperes, and an 8-inch distance from cathode to skin.

During the past three years we have entirely discarded the fractional, repeated doses of X-ray to plantar warts. Our percentage of cures has risen 20 per cent since employing the single, massive dose. We have never repeated the dose inside of two months, and we have seen warts disappear ten weeks after the one initial, maximum dose. We have never given more than two maximum doses to a single wart.

Out of a total of 322 patients with plantar warts, 220 were treated with X-ray, and the result noted. Of these, 176 were cured with one treatment, or a percentage of 80; 17 patients were cured with two X-ray treatments, or a percentage of 7.7, giving a total percentage of 87.7 cured by X-ray alone. Thirteen patients were not cured by X-ray, and were later operated on with electrocoagulation, all of them being cured. Five patients were not cured by electrocoagulation, but were cured with X-ray following. Thirty-nine patients were cured with electrocoagulation alone. Five patients required two operations with electrocoagulation, before they were cured. During the past three years only six patients have been treated with radium, with three failures, due to the fact that they were unusually difficult cases. These three failures were later cured by electrocoagulation. Nine patients out of a total of 220 that we have been able to follow have not been cured by any method which we have employed. An analysis of our failures shows the following facts:

1. It is foolhardy and dangerous to attempt to cure a plantar wart with radiation, if it does not respond to one or two maximum doses.

2. Some warts are resistant to radiation, and although a mild reaction takes place from treatment the warts persist. These lesions should not be treated further.

3. It is well to note the condition of the peripheral arterial circulation before treating a plantar wart. Most of our failures have been in patients in whom the peripheral arteries have been damaged either from arteriosclerosis, Buerger's disease, diabetes, or trophic disturbances from neurosyphilis. We have made a firm rule never to treat more than once a plantar wart occurring in an individual with damaged peripheral circulation, and if no result is secured, operative procedures are recommended.

4. It is unwise to further radiate a lesion that has been radiated elsewhere, unless the exact dose given is known.

Thirty patients out of a total of 44 who were cured by electrocoagulation, had received previous radiation treatment elsewhere, and all were suffering from the effects of overradiation. Anyone who has observed the extreme suffering to which these patients are subjected for months, and even years, cannot help but feel the tremendous responsibility in treating plantar warts with radiation therapy. We firmly believe that it is a mistake to promise cure of a plantar wart with radiation therapy, and then of necessity continue the treatment to the point of a severe reaction. It is much better to give the patient an exact percentage chance of cure, and if one or two treatments fail, remove the lesion with the high frequency current in one form or another. When over ten or fifteen warts are present, they are best removed by electrothermic means. Ten of our patients had over fifty warts on one or both feet. The warts were first coagulated or dissected as thoroughly as possible, and then the lesion was curetted out and the base treated again until all the spongy wart tissue was destroyed. These lesions usually require confinement to bed for from a week to two months, depending upon their size and the previous radiation therapy.

The treatment of warts on the hands is a problem somewhat different from the treatment of plantar warts. In general, the horny layer is not so thick, and the lesions occasion very little or no pain. When the lesions are multiple, we believe that the best

method of treatment is the destruction with electrodesiccation or electrocoagulation. Isolated lesions that can be very carefully trimmed down and outlined with lead foil, can be treated with X-ray. We have employed one massive dose to better advantage than repeated fractional doses. Our dose has varied from 2 to 6 skin units, depending upon the depth of the lesion. Out of a total of 248 patients with warts on the hands, 88 were treated by X-ray; 64 (or 72 per cent) were cured with one treatment; 7 were cured with two treatments, giving a total of 84 per cent cured with X-ray. Those not cured with X-ray were later cured with electrodesiccation.

Warts occurring elsewhere on the body than hands and feet have all been treated with the high frequency current, either in the form of electrodesiccation or electrocoagulation. Our results have been uniformly satisfactory, and with experience one becomes very proficient in destroying warts on the face, with a minimum of scarring. The infectious nature of these warts should never be overlooked, nor the fact that the incubation period is from four to seven weeks. For this reason we should not be content to destroy the lesions present at the time, but should examine the patient at intervals of from one to two weeks, for several months before discharging him as cured. This is especially true of warts on the face and neck of male adults. Shaving is the chief cause of spread in these cases, and care should be taken by the patient not to shave close.

The treatment of warts of various types with sulpharsphenamine intramuscularly has occasioned considerable interest, since the report by Sutton (7) of the treatment of six cases successfully by this means. He recommends its use, particularly in the juvenile type of warts on the hands. We have treated 45 patients of all ages with sulpharsphenamine, using as high as five doses. There were 20 cures, and 20 failures. Five patients were untraced. Nine patients were cured with one dose, 5 patients with two doses, 2 patients with three doses, 2 with four doses, and 2 with five doses. Of those that were not cured, 11 received one dose, 7 received two doses, and 2 received three doses. We have used sulpharsphenamine particularly in patients presenting a large number of warts on the face, neck, and hands, with the idea that the patients presented a difficult therapeutic problem, and if they did respond to sulpharsphenamine, it would be a fine achievement, whereas if they did not, nothing would be lost and the lesions later could be destroyed by other means. Our results have been better in individuals past the age of puberty. We feel that sulpharsphenamine has a place in the treatment of these difficult cases, but that it should not be used indiscriminately.

CONCLUSIONS

1. The diagnosis and treatment of plantar warts is a subject demanding much care and consideration on the part of the physician.

2. The infectious nature of warts should always be borne in mind.

3. We believe that X-ray is preferable to radium in the treatment of warts.

4. We believe that one massive dose is preferable to the fractional dose method.

5. The essentials of the X-ray treatment of plantar warts should consist of *(a)* careful paring off of the keratotic covering, *(b)* careful approximation of lead foil to the exact periphery of the wart, *(c)* rigidity of the foot during the treatment, *(d)* when normal tissue is not exposed to the X-ray, the total dose can be as high as 8 skin units.

6. The percentage of plantar warts cured with one treatment was 80 per cent; with two treatments, 7.7 per cent, giving a total percentage of 87.7 per cent cured by X-ray alone.

7. If plantar warts do not respond to

one or two maximum doses of X-ray, they should be destroyed thoroughly by electrothermic means.

8. Attention should be paid to the peripheral vascular condition. Failures occur more commonly in patients with damaged vasculature.

9. Electrodesiccation and electrocoagulation are the methods of choice in the treatment of the majority of patients with warts on the hands, face, neck, genitalia, and general body surface. Isolated warts on the hands can be treated with X-ray, using the same technic as in plantar warts, with smaller dosage.

10. Sulpharsphenamine should be judiciously used in the treatment of extensive warts on the hands, face, neck, and elsewhere.

REFERENCES

(1) JADASSOHN, J.: Verhandl. d. Deutsch. Dermat. Geschellsch., 1896, V, 497.
(2) WILE, U. J., and KINGERY, L. B.: Jour. Am. Med. Assn., Sept. 27, 1919, LXXIII, 970.
(3) MICHAEL, JEFFREY C.: Arch. Dermat. and Syphil., January, 1926, XIII, 658.
(4) TAUSSIG, LAURENCE R., and MILLER, HIRAM E.: Am. Jour. Roentgenol. and Rad. Ther., December, 1928, XX, 514.
(5) MACKEE, GEORGE M.: X-rays and Radium in the Treatment of Diseases of the Skin. Lea & Febiger, Philadelphia, Second Ed., 1927.
(6) HAZEN, H. H., and EICHENLAUB, F. J.: Jour. Am. Med. Assn., May 8, 1920, LXXIV, 1311. Idem: Jour. Am. Med. Assn., Oct. 28, 1922, LXXIX, 1487.
(7) SUTTON, RICHARD L.: Jour. Am. Med. Assn., Oct. 2, 1926, LXXXVII, 1127.

CONSTANT TEMPERATURE FOR X-RAY DEVELOPING

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DIAGNOSTICIANS are now reading shadows on X-ray negatives the existence of which was unsuspected even a few years ago. Progress in this field has been followed but slowly by better dark room technic, not because dark room people are less skillful, but because refrigeration manufacturers and designers have been slow to accept the challenge of a somewhat undeveloped market, and the importance of the dark room as a factor in beautiful technical work has been underestimated. It is the purpose of this paper to present a design for a developing tank which will hold the water flow and temperature within far closer limits than has heretofore been the practice, and thus permit exact control of the developing process.

With equipment of this type, the technician merely leaves the films in the developer for five minutes, removes them for a rinse, leaves them in the hypo for ten minutes, puts them through a double wash, and the job is ready for the dryer. He needs to watch nothing but time, and the alarm clocks to be had have already made that almost automatic. "Eye development," which has spoiled more good negatives than ever worn-out hypo has, is never necessary.

TANKS

The set-up is shown diagrammatically in Figure 1, with a sealed unit type refrigerating machine at the end of a typical tank arrangement, with the films progressing logically from left to right. The tap water gets its initial temperature drop in the precooler (of which more later), going then to the weir float control, and enters the main tank just to the left of the chilling unit. Having been further cooled at this point, the water flows past the helical sensitive bulb of an accurate electrical control, which will turn on and off the motor of the refrigerating machine upon a plus or minus half-degree variation in water temperature. This water, with its temperature so accurately maintained, then flows around the developer inset, progressing through the rinse compartment, around the hypo inset, detouring to the second or "sweet water" wash, then to the rough wash, and out to the precooler.

The developer tank is a standard five-gallon size, which will hold six or seven films. Since the films should stay in the hypo ten minutes, the hypo inset is the ten-gallon size and will take from 12 to 14 films. The souse between the two is as wide as the developer inset.

The washing arrangement is the well known Eastman "double wash," described in their *X-ray Bulletin,* August, 1929. Two tanks of equal size are provided, the first (through which the water flows *last*) for rough wash and the second for sweet water wash. The down-flowing water in the rough wash more efficiently removes the hypo, while in the rinse tank, with most of the hypo gone, the direction of water flow is unimportant.[1]

Each of the wash tanks is of nine gallons capacity, a size which easily takes seven films. It has been found that a total washing time of 15 minutes gives acceptable results if the water flow per hour is four times the volume of the wash compartment. In order to take care of overloads and other conditions imposing unusual demands on

[1] Permanganate tests with this type of tank at the Los Angeles General Hospital have shown the sweet water wash to be completely hypo-free.

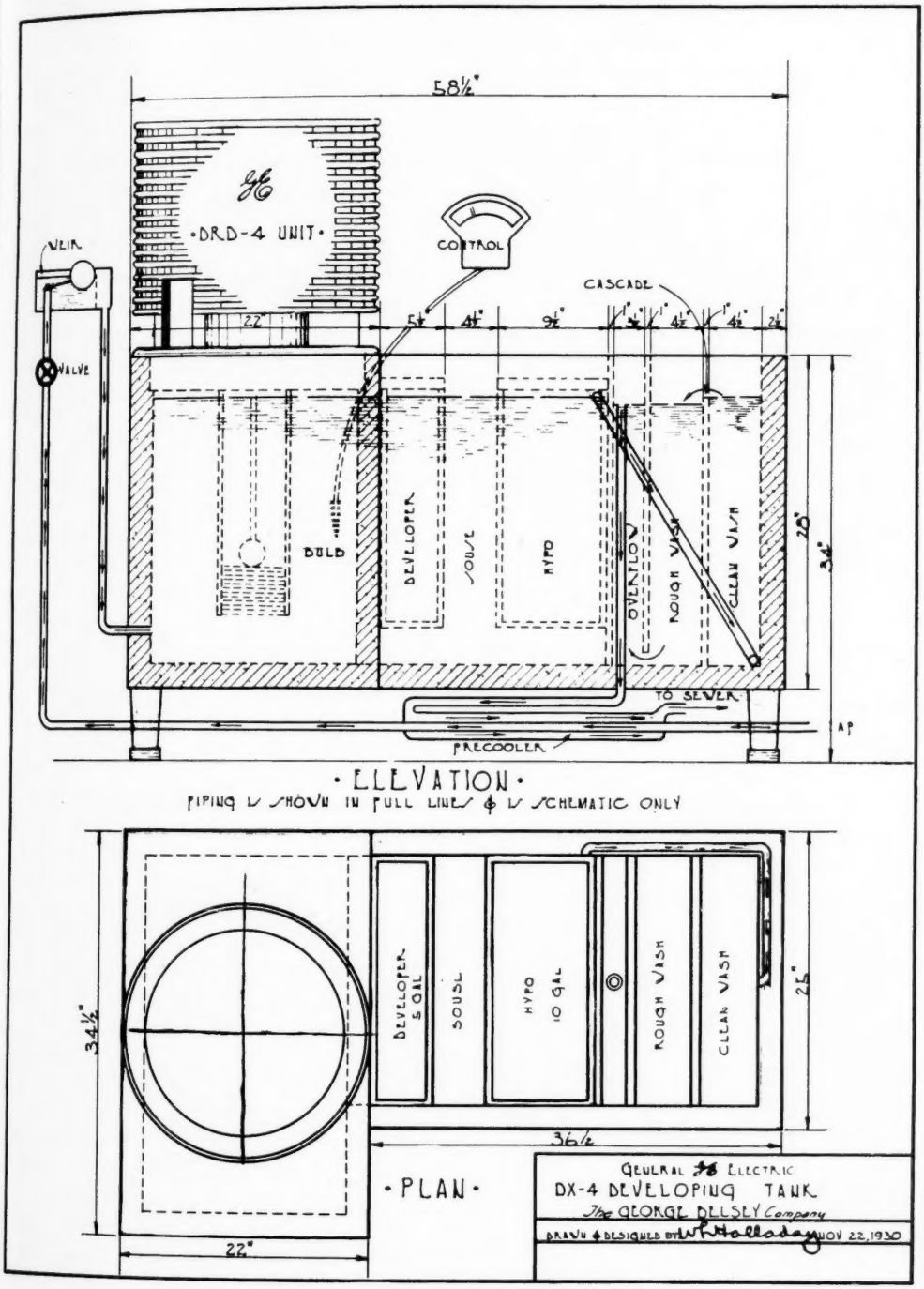


Fig. 1. General plan of the set-up.

the dark room, the writer has added about 50 per cent to this figure and assumed a flow of fifty gallons per hour, upon which the rest of the calculations will be based.

The tanks by all means should be insulated with two inches of corkboard or the equivalent, not merely to save refrigeration, but to protect the flowing water from changes in room temperature. The top of the tank is open, but it will be found that less heat escapes from the top than from uninsulated sides and bottom.

The lining of the tank brings in as many ideas as designers, with specifications ranging from alberene to redwood, to galvanized iron or lead, to stainless steel and monel. All of them are more or less satisfactory, though there seems to be a trend now toward 18-gauge full finished monel—somewhat expensive, but capable of beautiful workmanship and long life, particularly if the hypo is syphoned out (or removed by an injector) and not dumped into the tank.

The outside may be galvanized or lacquered iron. The top should be protected by a monel apron, extending well down over the sides.

PRECOOLER

Precooling, or heat exchanging, is an old trick, but it is amazing how designers in a new field fail to look for the old and proven ways of doing things. (Let the refrigerating engineer study boiler room design if he would be economical of his British thermal units!) It has been said that a precooler in X-ray work should do two-thirds of the refrigerating job. It can be shown that a precooler with warm tap water can do over five-sixths of the job, yet one designed for the same ultimate temperature will do less than one-third of the job with cool tap water, and it is unnecessary that it should do more.

To develop the precooler formula, let us take two heat transfer formulæ:

$$H = U\,S\,\triangle t \qquad (1)$$

$$H = (T_1 - T_2)\,Q\,D, \text{ where} \qquad (2)$$

H is heat transferred, B.t.u.'s per hour,
U is a "constant" of the transfer surface, varying from 30 for iron to 60 for tin,
S is heat transfer surface in square feet,
$\triangle t$ is mean temperature difference, degrees F.,
T_1 is tap water temperature,
T_2 is temperature of water cooled by precooler,
Q is water flow, gallons per hour, and
D is water density, 8.35 pounds per gallon.

The second equation merely says that the heat transferred is equal to the weight of water times the number of degrees cooled.

In the general type of heat exchanger or precooler, the mean temperature difference is a logarithmic function of four temperatures:

T_1, the first temperature of water to be cooled,
T_2, the final temperature of the cooled water,
t_1, initial temperature of cooling water, and
t_2, the final temperature of cooling water.

Gebhardt has shown that

$$\triangle t = \frac{(T_1 - t_2) - (T_2 - t_1)}{\log_e \dfrac{T_1 - t_2}{T_2 - t_1}} \qquad (3)$$

In the X-ray precooler, the cooling water has the same rate of flow as the incoming water, in which case the temperature that the cooled water loses is equal to that which the cooling water gains; or

$$T_1 - T_2 = t_2 - t_1, \text{ or}$$

$$T_1 - t_2 = T_2 - t_1. \qquad (4)$$

Attempting to substitute in the general equation (3) gives the indeterminate form $\frac{0}{0}$, but if we assume that $(T_1 - t_2)$ is a constant, and take the derivatives of numerator and denominator, we obtain

Fig. 2. Chart for designing the X-ray precooler.

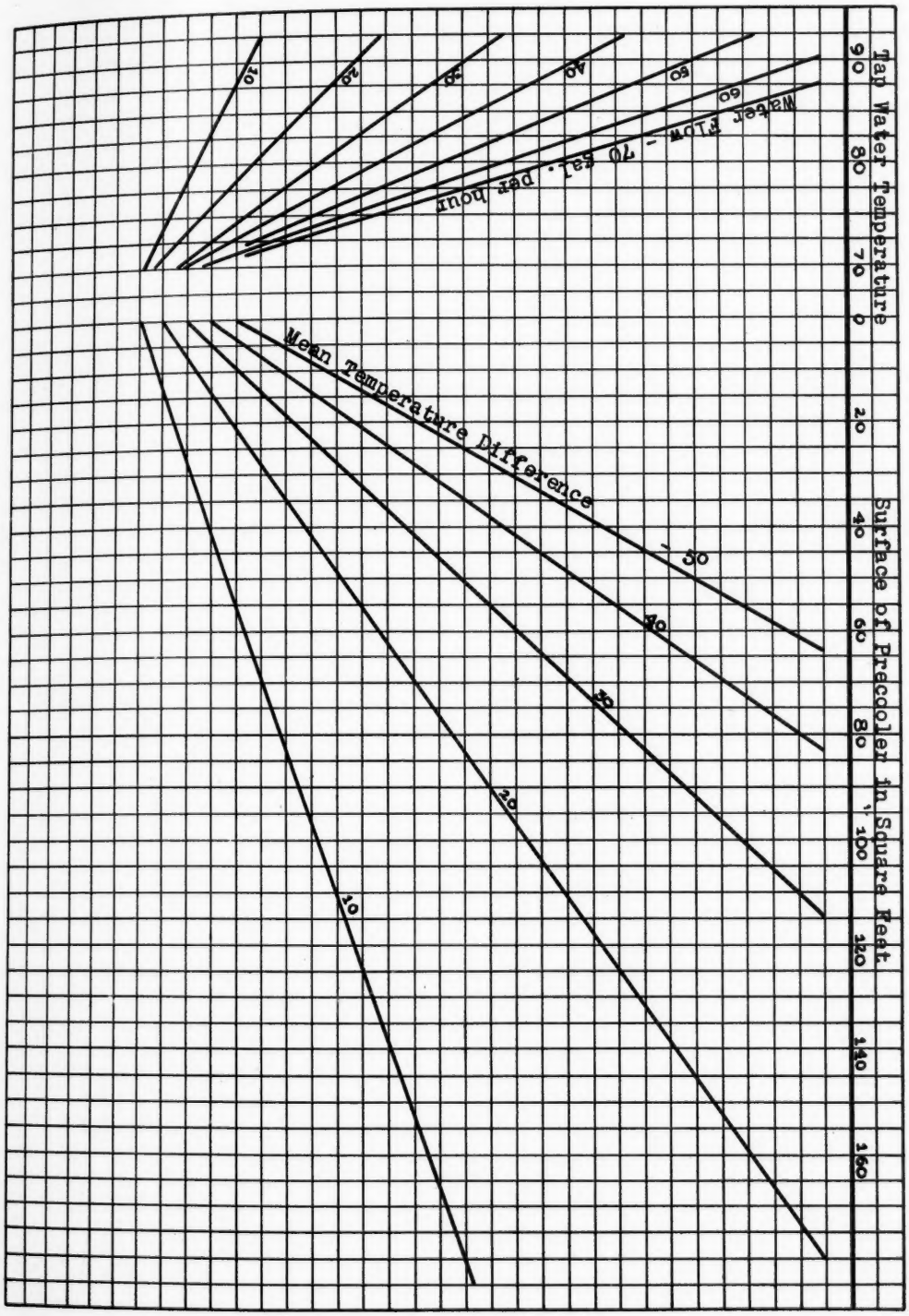


Fig. 2. Chart for designing the X-ray precooler.

$$\frac{dt}{d(T_2 - t_1)} = \frac{1}{1/(T_2 - t_1)} = T_2 - t_1.$$

This is a mathematical statement that as the loss in temperature of the cooled water approaches the gain of temperature of the cooling water, the mean temperature difference approaches $(T_2 - t_1)$, which is the arithmetical difference between the initial temperature of the cooling water and the final temperature of the cooled water. In general, good pre-cooler design should bring this mean temperature difference down to two degrees.

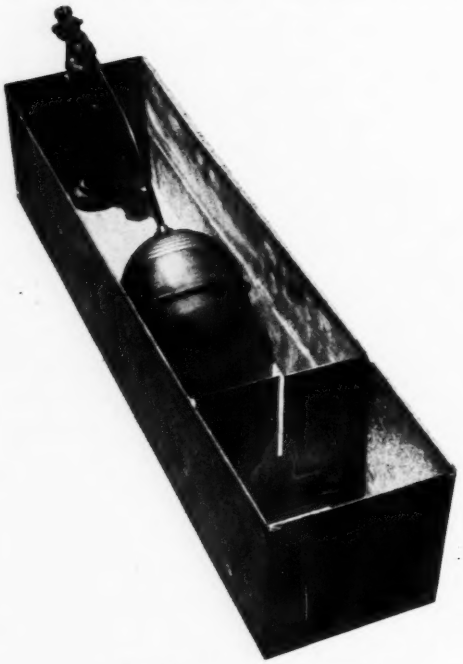


Fig. 3. Weir flow control.

Solving equations (1) and (2) for S, we have

$$S = \frac{(T_1 - T_2)\ Q\ D}{U\ \triangle t} \qquad (5)$$

Tests have indicated that with a developer temperature of 65 degrees, there may under unfavorable conditions be a rise of two degrees through the wash tanks, bringing the outflowing or contaminated water to 67 degrees. Since the mean temperature difference in the precooler is to be two degrees, it will be assumed that the precooler will bring the tap water to 69 degrees.

Let T_1 be 90 degrees, T_2 be 69 degrees, Q be 50 gallons per hour, assume U to be 30 for galvanized iron pipe, and $\triangle t$ be 2 degrees, then

$$S = \frac{(90 - 69)\ 50\ 8.35}{30\quad 2} = 146 \text{ square feet.}$$

The equation is diagrammatically solved on the chart, Figure 2, where the surface may be obtained if the tap water temperature, water flow, and desired mean temperature difference are known. Drop vertically from the tap water temperature figure to the intersection of the diagonal flow line, go horizontally to the intersection of the temperature difference line, then read the result as surface in square feet. These surface figures are based on a constant for standard iron pipe of 30; for copper or brass, multiply by 0.67; for block tin, multiply by 0.50.[2]

FLOW CONTROL

The weir is a well-known means of measuring water flow in an open channel. It is a special form of orifice, a constriction in the area of the channel so that the water must flow over an obstruction. The height of the water above the obstruction, or base of the weir, is called the head, and is a definite measure of the flow. In a rectangular weir the quantity of water flowing varies as the three-halves power of the head. It is easy, then, by holding the head constant, to hold a constant flow. The head can be kept at one value by an ordinary "low tank" water closet float and valve. Such an as-

[2]The writer recognizes that heat transfer through pipe walls is an extremely variable thing, dependent upon thickness, size, shape, and cleanliness of the tubes, water velocity, amount of entrained air, and other factors, and may under particularly favorable circumstances run twice as high as calculated. Nevertheless, in X-ray pre-coolers, U will generally vary from 30 to 60, the better conducting metals giving the higher values.

sembly, with a weir of one-eighth inch width, is shown in Figure 3.

The heads of a one-eighth inch weir, corresponding to various water flows, are:

Water Flow Gallons per Hour	Head in Inches above Base of Weir
10	.58
20	.92
30	1.21
40	1.46
50	1.70
60	1.91
70	2.13

The use of a weir float control makes fussing with a manual valve unnecessary—when the tank is put into use, the water is turned on full force; the weir will attain its head and hold the flow for which it is set. The weir should be by-passed with a manually operated valve, which is normally closed, but which may be opened so the tank may be rapidly filled after cleaning.

TEMPERATURE CONTROL

The electrical control has its sensitive bulb placed half-way between the chilling unit of the refrigerating machine and the developer inset. In conducting the tests upon which this article is based, a Bristol Model 177 thermostat, with a 50–80 degree range and a special helical bulb, was used. Set to a differential of plus or minus one-half degree, its control of motor operation was so sensitive and accurate that for a three-day period, half the time with the wash water not flowing, the total variation in temperature at the center of the developer was 0.2 degree.

This thermostat (with its necessary relay) should operate to turn on and off the motor of the refrigerating machine. In localities where the winter tap water temperatures drop below 65 degrees, a reversing switch can be placed in the control circuit so that the thermostat will operate a 200-watt heater mounted in the bottom of the tank, under the chilling unit. If the tap water temperature undergoes great variation at frequent intervals, an additional thermostat could be placed in the tap water line, set to reverse the main control to the heater if the temperature be below 64 degrees, and to connect it to the refrigerating unit upon the resumption of higher temperatures.

REFRIGERATING UNIT

It has been said that a properly designed precooler should bring the tap water down to 69 degrees. The job of the refrigerating unit is, then, to drop it the other four degrees—to 65.

This, at a flow of 50 gallons per hour, represents a load of $4 \times 50 \times 8.35 = 1{,}670$ B.t.u.'s per hour.

Wall leakage in an 80-degree room will amount to about 250 B.t.u.'s per hour, so there is a total load of about 1,900 B.t.u.'s per hour. The refrigerating machine should then have a capacity 40 or 50 per cent greater than this, so that its running time will not be excessive and some factor of safety is left for hot weather conditions.

The machine used for the tests has the following specifications:

Motor	½ Hp., 220 volt, single phase. Power input 570 watts. Power factor 80–85 per cent.
Compressor	Twin oscillating cylinder type, direct connected to motor. Force feed oiling system. Hermetically sealed.
Condenser	Multiple, air cooled by natural circulation.
Evaporator	Cadmium plated copper, designed for water immersion.
Capacity	2,800 B.t.u.'s per hour, 80 degree room, 65 degree bath.

REMOTE COOLING

A word might be said about the type of design employing a remote electrically re-

frigerated water cooler, set to hold approximately 65 degrees and furnishing a constant flow of water as near this temperature as possible. In general, the writer's experience has been that this installation is not as satisfactory as that which this paper describes; there is an inevitable lag in temperature from the water cooler to the developing tank, giving rise to greater variations in temperature than should be permissible in an automatic device. After all, it is not enough merely to cool the water, or that the control be sensitive. The control must be properly placed near the point where the constant temperature is needed (in other words, near the developer inset); it must be accurate as well as sensitive. Remotely controlled cooling of water brings many variables into the problem: the room temperature's effect upon the heat leakage of the pipe leading from the cooler to the developing tank, upon the heat leakage of the tank itself; the heating effect of increased service upon the tanks (the cooling of hangers and films); the cooling effect of evaporation from the surface of the wash water, variable with bath and room temperatures, and relative humidity, and the slight heating effect of the developing and fixing reactions themselves, all of which are automatically compensated for by having the chilling unit and sensitive control bulb in the wash water surrounding the insets.

APPLICATION

In general, this type of tank is applicable to all locations where the tap water goes above 70 or 72 degrees. It is generally accepted that present type X-ray films should not be washed in water warmer than 72 degrees. If the water be colder than that the year round, a much simpler set-up is possible, with a very small flow (of the order of one gallon per hour) merely surrounding the developer inset, the washing being done in tap water. No precooling is necessary, and the refrigerating requirements may be handled by a tap from a refrigerated drinking fountain, with the accurate temperature controlled by a thermostatically operated heater or a Fulton sylphon regulator. Emphasis must be placed upon the fact that this type of equipment is not satisfactory if the tap water is liable at any time to go above 72.

Acknowledgment is offered Mr. George Wigger for valuable technical assistance, suggestions, and proofreading.

BIBLIOGRAPHY

DAUGHERTY, ROBERT L.: Hydraulics, 1919.
EASTMAN KODAK COMPANY: X-rays in Medicine, 1930; X-ray Bulletin and Clinical Photography, June, 1928, July, 1928, August, 1929, July, 1930.
GEBHARDT, GEORGE F.: Steam Power Plant Engineering, 1922.
HULL, HARRY B.: Household Refrigeration, 1926.
WIGGER, GEORGE: Specifications for Developing Tanks, Los Angeles County.
WOODS, FREDERICK S., and BAILEY, FREDERICK H.: Analytic Geometry and Calculus.

THE "QUALITY" OF AN X-RAY TUBE AND HOW TO MEASURE IT

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IN earlier papers the writer has described some investigations on the temperature rise of the anode of an X-ray tube and its load-carrying capacity and on the size and shape of the focal spot.[1]

Some of the conclusions are:

1. An anode of copper provided with a thin tungsten target may carry a load of 200 watts per sq. mm. for one second. A much larger load would result in too high a temperature and consequently in evaporation or melting of tungsten or copper.

2. The best type of focus is the line focus, with the X-ray beam at an angle of about 20° to the surface. Such a line focus carries a load which is one and a half to two times larger than that carried by a circular focus of equal area.

3. The size of the focal area is far less important than the type of focus and its load-carrying capacity per unit area or "specific capacity." For a given sharpness of definition, a large focus requires a longer distance, and, as the energy required for a given exposure time and the area of the focal spot are both proportional to the square of the distance, the required increase of load is exactly what the enlarged focal area will allow it to carry.

DEFINITION OF "QUALITY"

As far back as 1925 it was suggested by Franke[2] that the relation between the load-carrying capacity during one second and the focal area be called the "specific capacity" or "Güte" of an X-ray tube. It is not, however, the real area of the focal spot that matters so much, but the area of the "effective focus," the projection of the focal spot in the direction of the radiation. The "effective focus" depends upon the angle of the rays with the anode surface, or, in other words, on the type of focus used. The relation between the load-carrying capacity and the area of the "effective focus" determines the sharpness of definition attained in a given exposure time. We shall, therefore, in this paper call the quotient of the load-carrying capacity during one second and the area of the "effective focus" the "radiographic quality," or briefly, the "quality" of the tube.

$$Q = \frac{w}{f} \quad \frac{\text{K.W.}}{\text{mm.}^2}$$

(w = load-carrying capacity during one second in K.W., f = effective focal area as measured by a pin-hole camera, *viz.*, the real area of the focal spot multiplied by sin. φ, if φ is the angle between the beam of radiation and the focal surface.)

The "quality" of a good tube is

$$\frac{0.2}{\sin.\ \varphi}$$

as 0.2 is the "specific capacity," according to the first conclusion (see above).

We shall first consider the "central ray." This is in the direction perpendicular to the axis of the tube, making an angle of 20° with the anode surface in the case of the line focus and of 45° in the case of a circular focus. We are well aware that it is not only the "central ray" that is of interest, but we shall see later on how far our conclusions will have to be altered if we take into consideration the deviations

[1] Ueber den Temperaturverlauf an der Anode einer Röntgenröhre. Ztschr. f. techn. Physik, 1927, VIII, 271.
Der Brennfleck einer Röntgenröhre und die Belastbarkeit. Fortschr. a. d. Geb. d. Röntgenstr., 1929, XL, 284. Abstracted in Am. Jour. Roentgenol. and Rad. Ther., 1930, XXIII, 460.

[2] H. Franke, Brennfleck und Bildgebung. Verhandl. Deutsch. Röntgen-Gesellsch., 1925, XVI.

from the central direction, as they occur in practice.

For an angle of 20° with the anode surface the projection amounts to one-third of the actual area, as

$$\text{sin. } 20° = \frac{1}{3}.$$

For an angle of 45°, as in the case of a circular focus, the effective focus is roughly 0.7 of the actual area. Therefore the "quality" of a good line focus tube should be

$$Q = \frac{0.2}{\frac{1}{3}} = 0.6$$

and of a circular focus tube

$$Q = \frac{0.2}{0.7} = 0.28.$$

MEASUREMENT OF "QUALITY"

To determine the "quality" (Q) of a given X-ray tube it would be necessary and sufficient to measure the load-carrying capacity, w, and the size of the "effective focus." The latter is the easier, as it is sufficient to take a simple pin-hole picture in the direction of the radiation.

Not so easy, however, is the determination of the load-carrying capacity of a given tube. One could, of course, try experimentally what a tube can stand, but then the desired knowledge would be acquired only by sacrificing the tube itself. A better method would be to measure the load which heats the anode to a previously determined "safe temperature," say 2,600 degrees.

The method which will be described now is much simpler, however, and involves much less danger for the tube. It is the method used successfully by the writer and his collaborators during many years of laboratory practice, as well as in the manufacture of many thousands of Metalix tubes. The principle is as follows:

The temperature of the target at the end of the load is directly proportional to the applied energy, as proved by calculation.[3] Instead of applying a heavy load and measuring the temperature to find which load heats the anode exactly to the admissible temperature, say 2,600°, we apply only such a load that the temperature at the end of one second is half the permissible temperature, *viz.*, 1,300 degrees. The number of watts necessary to obtain this temperature is then 50 per cent of the total load-carrying capacity. By this method the tube is not at all in danger and there is a high degree of accuracy in the measurement. For a temperature of about 1,250°, the emission of light varies rapidly with the temperature. Experimentation shows that at about 1,250° the focal spot begins to glow slightly, that is to say, with the tube filament heated: it would probably glow at a much lower temperature if it were in complete darkness. The glow becomes quite distinct at 1,300°, and without much experience one can always tell with certainty whether the temperature is below 1,250° or above 1,300 degrees. Figure 1 clearly shows how a difference in brilliancy of, say, 50 per cent, means only a very little difference in temperature. This is the reason why the measurement can be made in an exact way. It is not even necessary to take the temperature after exactly one second, for the temperature rise after half a second is so very slow that a difference of half a second would have little effect. This is made clear by Figure 2, which shows the temperature rise in the first second and a half.

To see the focal spot it is, of course, necessary to adjust a small mirror in front of the aperture, or, if one looks directly into the tube, to apply at least one cm. of good lead glass.

The determination of the number of watts is easily done by taking always a constant voltage of 50,000 and by increasing the milliamperage until the focal spot shows

[3] A. Bouwers, Ueber den Temperaturverlauf an der Anode einer Röntgenröhre. Ztschr. f. techn. Physik, 1927, VIII 271.

its red glow. Say, for example, that we find 60 ma., then we know that

$$\frac{w}{2} = 50 \times 60 \text{ watts} = 3 \text{ K.W.}$$

or

$$w = 6 \text{ K.W.}$$

In other words, that the tube in question is a 6 kilowatt tube. It is necessary to be certain that the voltage is really 50,000, for very often practical switch tables appear to be unreliable as soon as currents exceed 50 milliamperes.

It is really astonishing to find how simple the method appears to be after one has tried it. Even if two investigators work under quite different conditions (difference of anode surface, of lighting of the anode by the filament, darkness of the room), my experience has been that the difference in their results as a rule does not exceed 10 per cent, without exact measurement of the temperature and simply by looking at the anode.

The method described above tells immediately how many kilowatts a tube will stand, *viz.*, 0.1 part of the milliamperage found, provided, of course, that the applied voltage was actually 50 kilovolts.

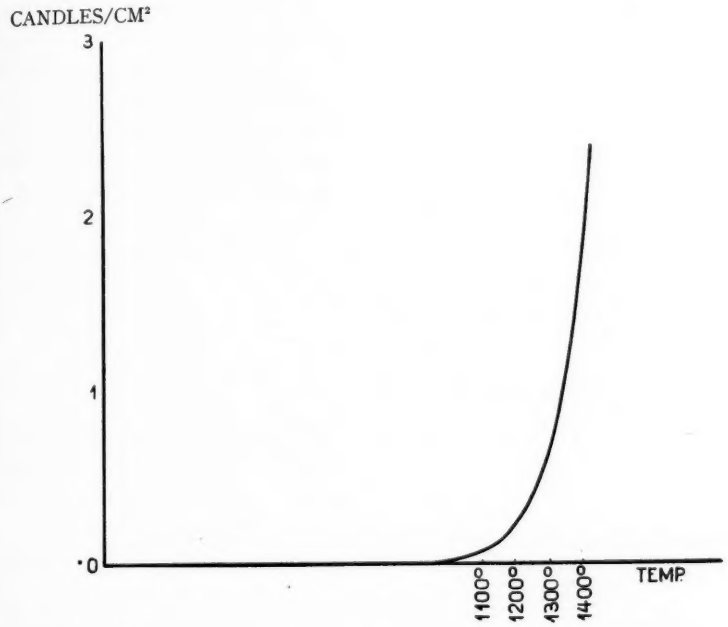


Fig. 1. Shows how a rough estimation of the light emission is sufficient for a fairly accurate measurement of the temperature.

The determination of the size of the focal spot in the central direction, as has already been said, is made by the simple pin-hole camera. It is unnecessary to describe the instrument, the only possible mistake here being the effect of exposure time and the size of the pin-hole. The size of the picture is not quite independent of the exposure time and increases with the same, as shown in a recent paper in *Röntgenpraxis*.[4] A simple geometrical equation proves that the size

[4] C. H. F. Müller A. G., Bedingungen für Lochkamera-Aufnahmen. Röntgenpraxis, 1930, II, 382.

of the picture should be somewhat broader than the actual focus:

$$F' = F + 2d,$$

if F′ is the width of the picture, F the width of the focal spot, and d the diameter of the pin-hole. This relation holds good

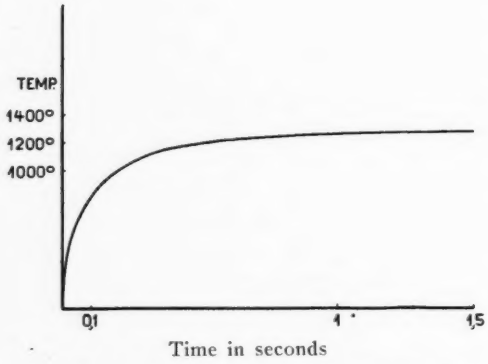


Fig. 2. Shows the slow rise of temperature of the anode after about half a second.

for equal distances between pin-hole and film, but only for a definite exposure time. With an exposure of 10 ma.-sec. at 50 K.V., the width F′ of the picture, according to practical experience, will be very nearly F + d, if the pin-hole is 0.2 mm. wide and the distances between pin-hole and focus and pin-hole and film, respectively, 15 centimeters.

Now let us assume that for the current necessary to cause the "glow" as described above, we found again 60 ma., and for the surface of the "effective" focal spot $3.2 \times 3.2 = 10.2$ square millimeters. Then the quality

$$Q = \frac{60}{10.\quad 10.2} = 0.6 \text{ (very nearly)}.$$

Testing a good line focus tube on "quality" one will always find about

$Q = 0.6$, sometimes 0.7 or even 0.75.[5]

A tube with a "quality" of less than 0.5 should definitely be rejected unless, of course, one wishes to employ circular focus tubes, in which case the "quality" never can be more than about 0.35.

The striking difference in "quality" between line focus and circular focus tubes is due only to the difference in projection angles, as explained above. The conclusion is correct that for the same definition a line focus tube can carry a load which is more than twice as large as the permissible load in the case of a circular focus, as long as the desired beam of radiation forms a small angle with the "central ray." That is to say, for all cases in which the length of the film, measured in the direction of the tube, is small in comparison to the distance from focus to film, as is very often the case in practice.

LARGE FILMS AND SHORT DISTANCES

We now come to the discussion of the case of a large film at a short distance, in which instance the part of the film nearest to the cathode will have the poorest definition, and we have to investigate whether or not the definition at this part of the film appears to be poorer in the case of a line focus than in the case of a circular focus, or otherwise.

Let us consider a 14×17 inch or a 35×42 cm. film at a distance of 25 inches or 64 centimeters.[6] We determine the most unfavorable direction of radiation, which proves to be at 18° with the "central ray" or at 38° with the anode surface in the case of a line focus, and at 64° in the case of a circular focus.

$$\frac{21}{64} = \text{tang. } 18°.$$

In order to see whether a line focus tube gives a poorer definition in this direction than a circular focus of the same area, we have to determine the length of the "effective focus" in both cases.

Let the line focus have a width a; its length will then be 3a and its area

$$3a \times a = 3a^2.$$

[5]Which would mean 250 watts per square millimeter.

[6]Compare RADIOLOGY, October, 1929, XIII, 288.

The actual shape of a circular focus is an ellipse with an area

$$\frac{\pi\, l^2}{4\sqrt{2}}$$

if its length is 1. If both areas are equal

$$\frac{\pi\, l^2}{4\sqrt{2}} = 3\ a^2$$

or

$$l = 2.32\ a.$$

The length of the "effective" line focus will be

$$3a \sin. 38^\circ = 1.8\ a$$

and the length of the "effective" circular focus

$$2.32\ a \sin. 63^\circ = 2.1\ a.$$

Even if one wishes to consider not the length of the focal spot but that of the diagonal of the rectangle, the latter will prove to be 2a, and, therefore, also smaller than the length of the "effective" circular focus. But then, it is easy to show that the extreme corners of the rectangle contribute very little to the total energy, and, therefore, the length of the diagonal is really too pessimistic a measure for the sharpness. Only for the very corners of the 14 × 17 film, it must be admitted that the longest diagonal of the "effective" line focus becomes exactly as long as the maximal diameter of the "effective" circular focus, *viz.*, 2.3 a.

It follows that the sharpness of definition in the most unfavorable direction is better with a line focus than with a circular focus, even if films of 14 × 17 inches are used at a distance of 64 cm., which is, I believe, hardly necessary in practice. The calculated data do not express the difference in average definition at the most unfavorable part of the film, but only the difference in definition in one direction.

The difference in favor of the line focus is much greater for all other parts of the film and even much greater for all parts if we use the film at right-angles to the tube, in which case the breadth of the focus will be parallel to the long dimension of the film. It was, however, our intention to discuss the most unfavorable direction of all, and we have chosen the largest size of film and the smallest distance probably ever used in practice with large films.[7]

THEORY AND PRACTICE

Although apart from this reasoning many experimental tests and many years of practical experience in radiology have proved the advantage of the line focus principle,[8] some investigators have come to the conclusion that the above-mentioned advantage does not exist.[9] It is hard to say by what complications of circumstances such results are not in accordance with the facts. I wish to make, however, a few general remarks.

(1) It is not always kept well in mind that the sharpness of definition is of great importance only if considered in its relation to the load-carrying capacity. It is quite clear that a tube with circular focus can give a better definition, at the same distance, than another tube with a line focus. But what we have tried to prove in this article is that in such a case the line focus withstands a much heavier load. This is not a circumstance of secondary importance, but, on the contrary, the quintessence of the question. The advantage of the heavier load can be applied to obtain a better definition: first, by increasing the distance; second, by decreasing the exposure time and therefore the effect of the deplacements of the object, and third, by partly combining both improvements.

(2) On some occasions we have proved

[7] See Footnote 6.

[8] Compare H. Franke, Ueber die grundsätzliche Bedeutung einer für jede Belastung scharf zeichnenden Röhre. Fortschr. a. d. Geb. d. Röntgenstr., 1925, XXXIII, 111.

H. Franke, Comparaison pratique de la finesse des radiographies: Les Rayons X. Revue Trimestr. de Clinique et de Thérapeutique, 1926.

L. G. Heilbron, Ueber eine neue Röntgenröhre mit sehr grossem Schärfe-Index. Fortschr. a. d. Geb. d. Röntgenstr., 1922, XXIX, 299.

I. S. Hirsch, Discussion of Self-protecting Tubes and Their Influence on the Development of X-ray Technic, A. Bouwers. RADIOLOGY, September, 1929, XIII, 191.

[9] See M. Belot, Jour. de Radiologie, IX. Also W. C. Barker, RADIOLOGY, October, 1929, XIII, 283.

that the line focus tube had not been used in the right position. Care should be taken that the tube itself be almost parallel to the film and that the "central ray," perpendicular to tube and film, pass through the center of the latter.

(3) The comparison of two reproductions of radiograms is sometimes misleading. If details in one reproduction seem to be more pronounced than in another, there is, apart from the variations incident to the process of reproduction, the question of the distance of the details in question from the film. An object nearer to the film in one radiogram will certainly show sharper with the worst tube than a similar object taken with the best tube at a disadvantageous distance from the film.

(4) If two radiograms are compared, one made with a fine focus tube and the other with a broad focus tube, one can always find parts so near the film that they show with almost equal clearness. This is, however, like comparing a high power racing-car and a moderately slow machine, running both at ten miles an hour, and stating that there is no difference in speed.

(5) The writer of the present paper has refrained from publishing some of the numerous experimental proofs that the line focus gives better definition in every possible case in practice, because he hopes that the reasoning in this paper is a better proof than any reproductions can be.

To the writer it seems that these remarks may contain the key to the explanation of most of the discrepancy between theory and some practical results.

COMPARISON OF X-RAY DIFFRACTION INTENSITIES WITH STRUCTURE FACTOR COMPUTATIONS IN LIQUID LONG CHAIN COMPOUNDS

By ROSS D. SPANGLER, University of Iowa, Iowa City, Iowa

Abstract.—The concept of effective molecular grouping in liquids is used as a foundation on which to base computations of relative intensities at certain angles of diffraction of X-rays from eleven n-alcohols and twenty-two octyl alcohols. The intensities are obtained by calculations of structure factor based upon an assumed but reasonable molecular structure. The satisfactory nature of the comparison adds evidence distinctly in favor of the molecular group conception of the cause of the diffraction haloes in liquids.

KNOWLEDGE of the nature of the liquid state is of fundamental importance. One of the methods of approach is a study of the arrangement of molecules in liquids. This aspect has been emphasized at this laboratory, the name cybotaxis being given to the molecular groupings found in liquids.[1] But, as usually is the case in fundamental problems, the evidence involves interpretations and can wisely become convincing only by an accumulation of data from every possible angle of approach. The cybotactic view is one of importance, for, if correct, it should supply the conception necessary for more complete theories of numerous phenomena in liquids, such as viscosity, solubility, and osmosis. The purpose of the present paper is to add pertinent evidence through quantitative comparisons of the relative intensities in X-ray diffraction haloes in liquids with similar values computed from structure factors.

The dotted line curves in Figure 1 show the relative ionization intensities[2] in the X-ray diffraction in the n-alcohols from methyl to lauryl, inclusive. The zero points of the ordinates have been shifted to make possible the presentation in one figure. Two peaks in each curve are noticed. The larger one is interpreted as corresponding to the lateral separation of these chain molecules and the smaller one to the longitudinal separation, the word "separation" referring to the diffraction centers of the molecules.[3] It ought to be possible to make a comparison of the relative intensities of any one substance by computing the structure factor and adopting the space arrangement of the molecules just mentioned. Such has been the method.

Since we are not dealing with crystalline structure, but with groupings that are unstable and crude approximations thereto, several assumptions are necessary in order to make the comparisons. They are as follows:

(1) The electrons in an atom scatter X-rays classically and may be regarded as concentrated at the center of the atom. In justification for both assumptions the small angle of scattering should be noted. (2) The structure of the molecule may be obtained from the general conception in chemistry of such long chain molecules combined with certain measurements in X-ray diffraction in n-paraffins and n-alcohols, and from the crystal structure of diamond. (3) The group arrangement is regarded as that already suggested by the workers in this laboratory. (4) The classical theory of structure factor as developed for crystals may be applied to the liquid groups as a first approximation in the computation of relative intensities at different angles.

In accord with Assumption (2) the arrangement of the atoms in the molecules is found by a succession of steps. The lengths of a homologous series of molecules of n-

[1] See Stewart: Phys. Rev., 1930, XXXV, 726, for the evidence for this view.

[2] Obtained by Stewart and Morrow, *loc. cit.*

[3] For the details of the arrangement suggested the article by Stewart and Morrow, *loc. cit.*, should be consulted.

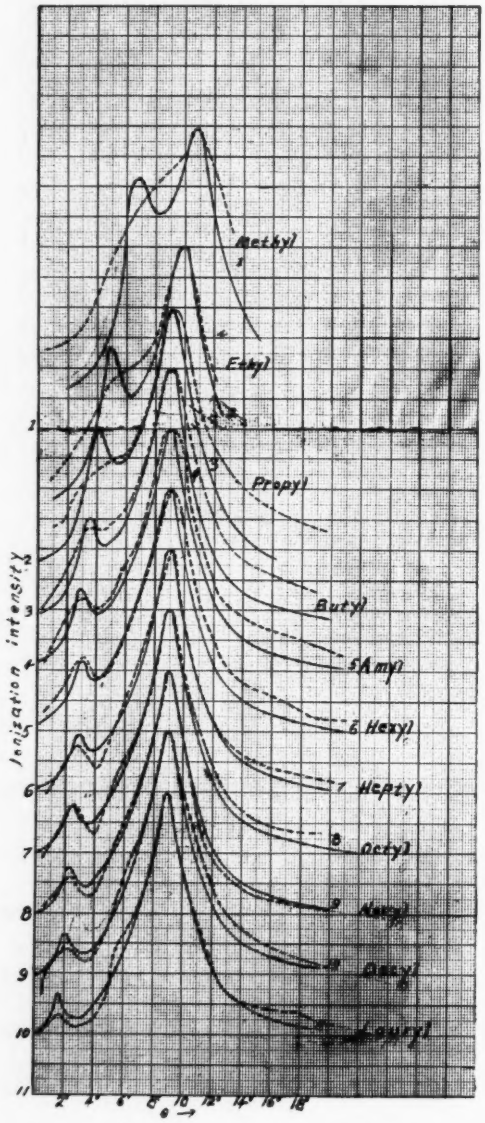


Fig. 1. Comparison of experimental and structure factor diffraction curves for n-alcohols.

alcohols and n-paraffins are computed by a formula[4]

$$L = \frac{\text{Mol. Wt.} \times M_H}{\text{Density} \times d^2},$$ wherein d is the separation normal to the direction of the chains found by X-ray diffraction. The chains are in a square array. M_H is the mass of an H atom. Knowing L, the increase in length of a molecule per C-atom is found. The increase found for alcohols is 1.25 Å.u., and for the paraffins, 1.25 Ångström unit. With this accepted, the amount contributed by the end groups of the molecules, OH + H for the n-alcohols and H + H for the n-paraffins, are readily computed. These lengths were found to be, respectively, 2.08 Å.u. for the alcohol molecules and 2.62 Å.u. for the paraffins. In the paraffins, then, each H-atom contributes 1.31 Å.u. to the length of a molecule. Assuming that a similar geometrical arrangement occurs at the H end of the n-alcohol molecule, we have $2.08 - 1.31 = 0.77$ Å.u. as the amount contributed to the length of an alcohol molecule by the OH-group. This space allowed to the OH-group is somewhat small, but if we think of the C-atoms being crowded about the OH-group, which does not seem improbable, the result is not unreasonable. This crowding has been pointed out by Müller when dealing with solid crystals of long chain compounds.[5] Of course it is to be understood that the foregoing estimations of the space occupied by OH and H are not considered accurate except as they are sufficiently so for the purpose of this paper. If the diameter of the C-atom may be taken from the diamond as 1.54 Å.u.,[6] the C-atoms in the molecules concerned cannot, according to the foregoing measurements of 1.24 and 1.25 Å.u., lie on a straight line. If the C-atoms are connected to one another in a zigzag manner at the tetrahedral angle found in the diamond, the distance between successive centers of C-atoms along the chain will be 1.255 Å.u., or very nearly the value computed above. This arrangement of the C-atoms in a zigzag manner has already been pointed out in the case of solid crystals of long chain compounds.[7, 8] Since the C-

[4] G. W. Stewart: Phys. Rev., 1928, XXXII, 153.

[5] A. Müller: Proc. Roy. Soc., 1927, 114 A, p. 542.

[6] W. H. Bragg: Introduction to Crystal Analysis, 1929 Ed.

[7] Müller and Shearer: Chem. Soc. Jour., 1923, CXXIII, 3156.

[8] A. Müller: Proc. Roy. Soc., 1928, 120 A, p. 437.

atoms are connected to one another at tetrahedral angles, the H-atoms which belong to the long chain molecule may be assumed to be connected to the C-atoms at the same angle. This gives us a fairly definite model of a n-alcohol molecule on which to base our calculations. Having selected a structure of the n-alcohol molecule, the computation of the structure factor for any set of planes in the molecular group is obtained by the formula,[9]

$$F = \Sigma n_i \cos\left(2\pi \frac{2z_i \sin\theta}{\lambda}\right),$$

where n_i is the number of electrons in an atom at a distance z_i from a diffracting plane containing the diffraction centers. n_i and z_i are summed up over the molecule. The arrangement of the molecules is assumed, as stated by Stewart and Morrow *(loc. cit.)*, and is briefly described as consisting of an end-to-end longitudinal arrangement with polar groups adjacent and with these long chains, thus formed, parallel and in a square array.

In addition to the n-alcohols, twenty-two octyl alcohols are similarly treated. The details of the structures assumed will not be described, but they are in accord with the arrangement of molecules suggested by their diffraction curves.[10]

In terms of F, the energy in a scattered beam is assumed to be proportional to $F^2 / \sin 2\theta$.[11]

If F_1 and θ_1 refer to sets of planes which are parallel to the lengths of the molecules and if F_2 and θ_2 refer to sets of planes through the ends of the molecules, $\frac{F_2^2 / \sin 2\theta_2}{F_1^2 / \sin 2\theta_1} = W_2 / W_1$ is the ratio of the energies of the diffracted beams from the two sets of planes. The values F_1, F_2, and W_2 / W_1 for the normal and octyl alcohols are given in Table I.

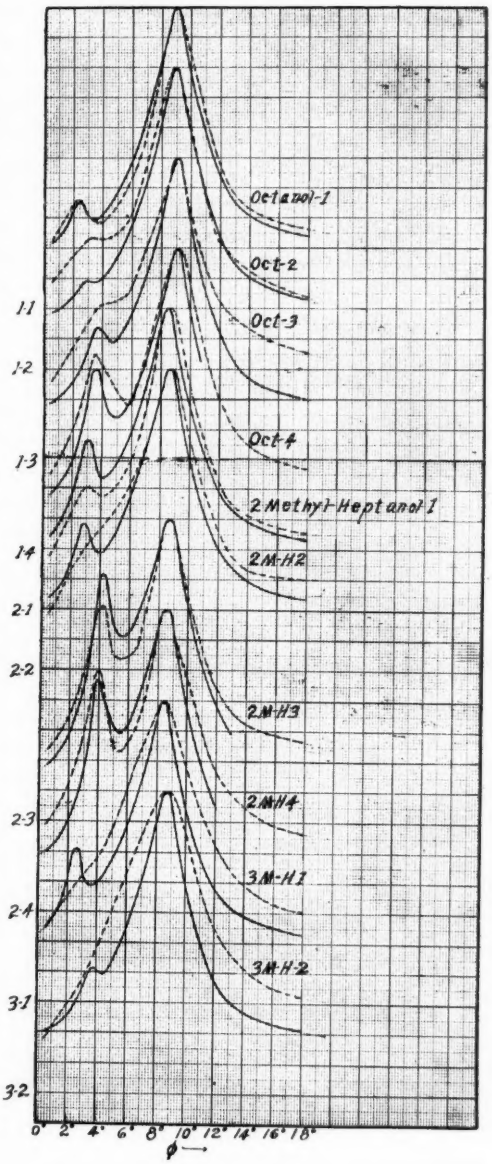


Fig. 2. Comparison of diffraction intensity-angle curves of octyl alcohol isomers and the curves constructed from structure factor computations.

It would now be possible to proceed with the comparison of W_2 / W_1 as computed, with the ratio of the heights of the corresponding peaks in the experimental dotted curves of Figures 1 to 4. But for the sake

[9] A. H. Compton: X-rays and Electrons, 1926, p. 121.
[10] G. W. Stewart: Phys. Rev., 1930, XXXV, 726.
[11] A. H. Compton: X-rays and Electrons, Chap. V, p. 125. The polarization factor is omitted because of its small variation at the angles herein used.

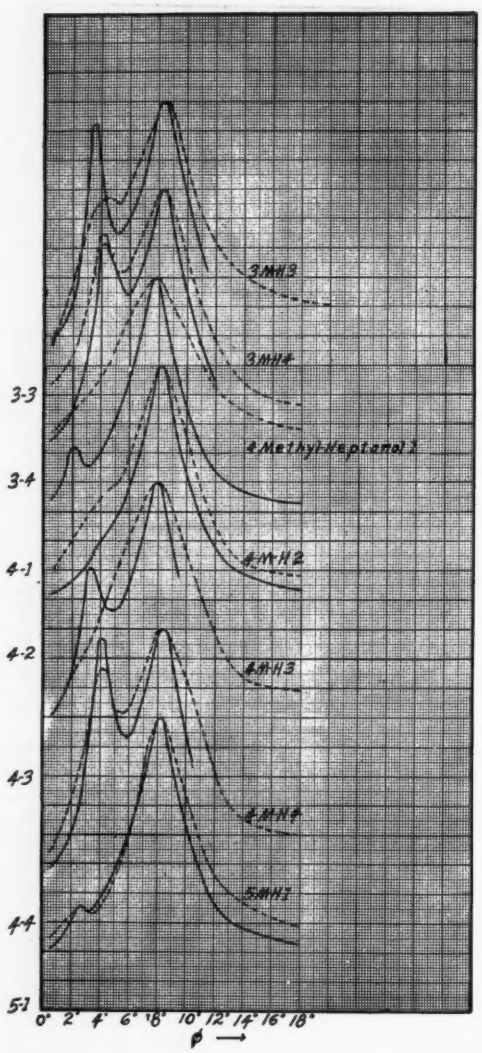


Fig. 3. Comparison of diffraction intensity-angle curves of octyl alcohol isomers and the curves constructed from structure factor computations.

of making the comparison more visual as shown by the full line curves in the above figures, it is necessary to assume the shape of the peak. This is taken to be that occurring in the n-paraffins. The width of this standard peak is assumed proportional to the angle of diffraction. The height of the peaks on the full line curves are now made to have the same ratio as the computed

TABLE 1

	F_1	F_2	W_2/W_1
Methyl	20.4	30.1	.65
Ethyl	21.8	41.7	.492
Propyl	22.3	53.4	.424
Butyl	22.6	65.0	.315
Amyl	22.68	76.6	.246
Hexyl	22.73	88.3	.201
Heptyl	22.8	99.9	.175
Octyl	22.61	111.7	.155
Nonyl	22.66	123.4	.134
Decyl	22.49	135.0	.136
Lauryl	22.37	146.6	.139
Octanol 1	22.61	111.74	.155
Octanol 2	15.51	99.5	.076
Octanol 3	39.7	99.5	.222
Octanol 4	43.28	99.5	.446
2 methyl-heptanol 1	34.08	103.27	.325
2 methyl-heptanol 2	25.34	91.84	.245
2 methyl-heptanol 3	51.4	91.84	.645
2 methyl-heptanol 4	47.8	91.84	.584
3 methyl-heptanol 1	29.5	103.27	.282
3 methyl-heptanol 2	20.7	91.84	.169
3 methyl-heptanol 3	57.2	91.84	.805
3 methyl-heptanol 4	56.39	91.84	.745
4 methyl-heptanol 1	24.46	104.85	.208
4 methyl-heptanol 2	15.0	96.54	.075
4 methyl-heptanol 3	58.0	96.54	.53
4 methyl-heptanol 4	60.6	96.54	.8
5 methyl-heptanol 1	18.18	97.17	.113
5 methyl-heptanol 2	9.56	96.54	.029
5 methyl-heptanol 3	53.38	96.54	.381
6 methyl-heptanol 1	12.81	103.27	.05
6 methyl-heptanol 2	7.26	91.84	.017
6 methyl-heptanol 3	44.7	91.84	.29

W_2/W_1, and the height of the chief peak is adjusted to correspond to the experimental. Also the angular positions are assumed to be that shown experimentally.

In making the above reduction of peak width when plotting for a smaller angle, the spread of 24′ caused by the apparatus is incorrectly altered also, but the error is too slight to warrant the more accurate procedure, since the visual effect would be scarcely changed thereby.

The curves for the normal and octyl alcohols, built up as described above, are shown in Figures 1, 2, 3, and 4, by the full lines. Superimposed upon each of the computed curves is the experimental one for the same sample, shown by the broken line. The

substances represented by the curves are indicated in each case.

RESULTS OF COMPARISON

Consider Figure 1, for the n-alcohols. There are ten of them. In all, except methyl, the comparison of widths of peaks shows good agreement. As regards intensities, in six of the ten there is good correspondence, that is, the two intensities at the smaller peak agree within about 30 per cent. Two others are within 70 per cent and with ethyl and methyl the agreement is poor. This poor agreement for the shortest molecules is to be expected, for the groups would be less well defined and hence our structure factor values would be less applicable. Also there is a known greater error introduced by the general radiation as the inner peak moves toward larger angles. The maximum of this general radiation is about 6°. One might, therefore, say that agreement in six of approximately eight fairly dependable curves is satisfactory.

In Figure 2, there is similar good agreement for six and perhaps seven of the ten. Perhaps a more detailed consideration of all the curves may be subsequently of value, but for the purpose of this article, the discussion will be limited. In Figure 3, four of the seven pair have good correspondence. In Figure 4, the correspondence is poor, except in one case of the five, but the inner peak is small. In this fact the agreement is satisfactory. Another significant fact is that only in four cases out of thirty-three is the experimental secondary peak more prominent than the computed one, whereas one would anticipate that our method would indicate better groupings for the smaller peak than really exist. To make clear the significance of the agreement and lack of agreement in the foregoing comparisons, it is well to bear in mind just what has been assumed. The four assumptions stated at the outset include not only the same reasonable assumptions that would be made with a powdered crystal, but also the details of the structures of the molecules, those assumed to have a rigid shape. Errors must certainly exist in these details. Moreover, the rigidity of the molecule is very doubtful; indeed, there seems to be no experimental fact that demands it. The question arises, with such rough approximations to the truth, can any definite conclusions be reached? Clearly the agreement in Figure 1, as explained, is satisfactory and is excellent evidence for the correctness of the cybotactic or group view. In all the other compounds shown, with the exception of octanol-1, or n-octyl alcohol, the molecules are not straight chains but have one or more branches. But our assumed structure states that these molecules are not warped by their branches in any way. In spite of the possible large error entailed by this assumption, there remains for the most

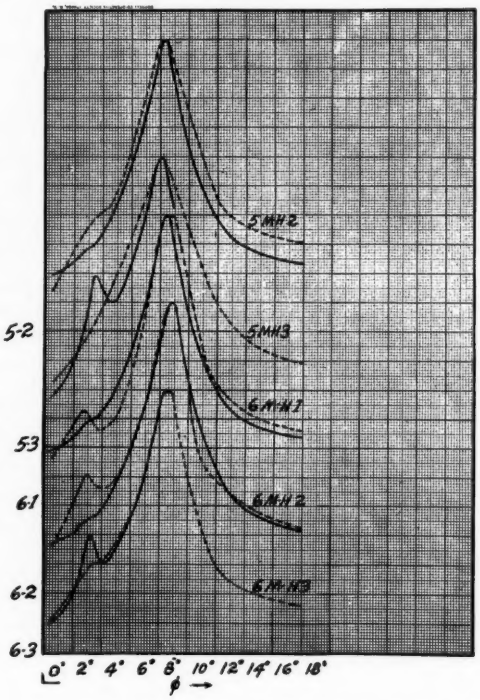


Fig. 4. Comparison of diffraction intensity-angle curves of octyl alcohol isomers and the curves constructed from structure factor computations.

part a striking resemblance of the actual and the constructed diffraction curves.

When one considers the limitations of the method of comparison here proposed, he must conclude that the evidence adduced by the comparison favors strongly the correctness of the view that molecular unstable groups of molecules, simulating crystal powder, are to be found at any instant throughout the liquid.

Anomalous Enlargement of the Liver and a Dissecting Hematoma of the Phrenic Nerve: Case Report. Karl Kornblum and George W. Stephenson. Am. Jour. Roentgenol. and Rad. Ther., July, 1930, XXIV, 38.

The authors report an interesting and unusual case of anomalous enlargement of the liver occurring in a patient 16 months of age, who had been examined clinically and roentgenologically on several occasions just prior to death, and postmortem examination. By roentgen study, a dense shadow was observed at the right base which, on the lateral film, gave the impression of being produced by an accumulation of fluid encapsulated between the middle and lower lobes. Upon postmortem examination, however, this was proven due to an anomalous enlargement of the right lobe of the liver, the thickness of this lobe being 15 centimeters. There was no evidence, either gross or microscopic, of any liver pathology. The writers were unable to find in the literature any reference to the frequency of occurrence of anomalous lobulation, except the statement by one authority that the condition is not rare.

J. E. Habbe, M.D.

WHAT SHOULD BE DONE ABOUT CANCER?[1]

By H. J. ULLMANN, M.D., Director, Department of Radiology and Cancer Research, Santa Barbara Cottage Hospital, SANTA BARBARA, CALIFORNIA

THOSE who desire to accomplish most for humanity in the field of cancer must survey several lines of effort for the possibilities of producing results.

1. Laboratory research to determine the cause of cancer.

2. Search for a specific cure.

3. Improvement and standardization of known methods of treatment.

4. Making such methods available to cancer sufferers.

5. Education of physicians and public.

1. *Search for cause.*—This has been going on for two generations, with the expenditure of millions of dollars, and, so far, we are but little nearer the answer. It can well be left to the few centers already engaged and experienced in the work.

2. *Search for cure.*—Man has looked for panaceas from the beginning of time; in the Middle Ages, for the fabulous philosopher's stone that would cure every ill—in more recent times for a specific remedy for a specific disease. Some success has rewarded such search, for example, quinine in malaria, antitoxin for diphtheria, serum for epidemic meningitis.

Man is still seeking such a specific for cancer, the scourge that cuts him off in the most productive period of life. Whether such a cure shall consist of an amulet hung around the neck, a "radio-active" drinking water, or a marvelous substance to be injected into the body, depends on the relative ignorance of the searchers.

For reasons that are only too painfully obvious to the intelligent student of cancer, it is extremely unlikely that any specific cure for cancer will ever be found, as cancer is not a single disease but the name of a whole group of diseases with certain common characteristics. Research which holds so little hope of success seems questionable judgment. But this does not apply to the development by clinical and laboratory research of successful methods of treatment when intelligently and skillfully applied, alone or in combination with other methods, even in the absence of a specific cure. The best example of the result of such research is insulin, a successful treatment but not a cure for diabetes.

It is believed that any effort toward relieving or attacking the cancer situation as a whole will go much farther in saving life and relieving suffering than if devoted to clinical or laboratory research alone. Clinical and laboratory research can not accomplish much without adequate facilities for caring for and treating cancer patients. If only a certain sum of money is available, it must be divided between furnishing these facilities and the laboratories. If it is spent entirely on what one might call "pure research" in the laboratory, much of the work will necessarily be abortive.

To be told that one has cancer does not necessarily mean a death sentence. The percentage of actual cures among the commoner forms of cancer is being increased every year as physicians become more and more skilled in the use of established and proven methods, and improvements in these methods are developed or discovered. Each year shows a steady and, in some instances, rapid increase in the percentage of cures within definite groups of cancers, and such orderly development in the treatment and

[1]Read before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

cure of this dread disease should proceed faster and faster as our knowledge increases.

At the present time many people are dying unnecessarily from cancer. There are several reasons for this situation. A slowness on the part of the patient to seek advice or submit to treatment after he knows that he has cancer is one. This may be classified as the ignorance of the public. Another is the lack of familiarity with the early signs and symptoms of cancer by a large proportion, probably a majority, of the medical profession. The lack of knowledge among physicians regarding advances in methods of treatment and possibility of cure leads them to pronounce cases hopeless, or to use only palliative treatment, when the percentage of cures from the best cancer clinics may be 30 per cent in that particular type of cancer. This may be classified as ignorance within the medical profession.

Few centers are equipped with adequate facilities for treating all types of cancer. These facilities consist of sufficient radium, roentgen-ray equipment, and a trained personnel—surgeons, radiologists, pathologists, and laboratory services—for both clinical and laboratory research. As it is possible for only a few patients to reach one of these centers, many deaths may be classified as due to lack of proper facilities.

There are three time-tried, accepted methods of treating cancer with a definite prospect of cure, and the percentage of cures, as has been stated, is increasing year by year. The exception is a small group of exceedingly malignant growths within which no cures have ever been reported.

The oldest of these methods is surgery. Surgery, however, has reached its limit, for, although the surgeon of to-day can remove practically any portion of the body that is not needed to support life, cancer may attack such regions or organs as are beyond his reach.

The second is the use of radium, the roentgen ray, or both in combination. Although their employment is recent, compared to surgery, they have become, when properly used, nearly as important, especially radium. Their importance has been well brought out in a recent report from the Cancer Commission of the League of Nations (1), and the last Annual Report of the British Empire Cancer Campaign to the House of Lords. The development of new methods of using radium, with accompanying improvements in results, is occurring so rapidly that it is difficult for any one not devoting a large part of his time and interest to the work to keep up with the rapid changes.

The third is a combination of surgery with radium and roentgen rays. This last furnishes the highest percentage of results in many of the more serious groups of cancer, but necessarily, to obtain these results, requires the closest co-operation between the surgeon, the radiologist, the pathologist, and the research laboratory.

There are other methods being continually tested, some of which show promise, but they are all so new that, although much work is being done both in developing and testing new methods, they will not be discussed.

This is the situation as it exists to-day, and the method of meeting it might be summarized under three heads: (1) Education of the public and the profession; (2) establishment of institutes with facilities for the care and treatment of cancer patients; (3) research. These can and should be combined in the larger centers and in many of the smaller.

Physicians are often responsible for donations for medical purposes, and where not directly responsible are usually called upon for advice. This paper is a plea that, so far as possible, those making donations to combat cancer be not only advised but urged to give their funds to meet the cancer problem

as a whole, not for any particular phase. The present tendency is, as soon as funds are provided, to erect and equip elaborate laboratory buildings, and the director of research is instructed to search for the cause of or a cure for cancer. No consideration is given those sufferers who might be relieved or cured if proper facilities for their care and treatment were provided. Each fund should be divided into three parts by the medical advisory board, and the relative size of these parts varied from time to time as the local situation demands. In this way the work will be balanced and the greatest benefit be obtained from any given amount of money available. For example, the laboratory research in an institution may reach an *impasse* or become abortive for lack of clinical material. The medical board may then divert sufficient funds to supply hospital accommodations until such time as the clinical research has caught up with the laboratory. Or again, the local situation may require a major portion of the budget to furnish facilities, such as radium, or to equip a clinic in order to obtain the greatest benefit for the cancer sufferers in that locality.

The physicians in the surrounding territory must be taught to recognize cancer and what to do when it is found. They must be taught that the treatment and diagnosis of cancer is a group problem and that team work with their colleagues is essential. They must be taught that the hopeless cancer sufferer must not be left to die with morphine as his only aid, but that the duty of a physician is to relieve suffering as well as to cure disease. The cancer sufferer is entitled to as much care and thought as the incurable cardiac patient. It is unfortunate that he rarely gets it, and I have discussed this phase in a previous paper (2).

With institutions in the larger centers completely equipped and adequately staffed, each with laboratory facilities for research, diagnostic centers should be established in the smaller cities. Such a smaller center must be complete for its purpose and the staff must include a trained pathologist. Here patients may be referred for diagnosis and advice, for the staff must be in constant touch with the parent institution. Patients who can not be properly treated locally are referred to the large treatment center, where all facilities, including free care for indigents, are available. It is economically unsound to install expensive roentgen outfits and large supplies of radium in every city. These should be concentrated in the special centers and these centers distributed so far as possible that they may serve the surrounding population with the minimum of transportation problems. Close co-operation with the public health services should be maintained. These are particularly valuable in keeping check on patients after treatment.

There is much money and effort being wasted from lack of organization and ignorance of the problems involved. It has been said that a problem formulated is half solved. I hope that what has been said will aid in that formulation.

SUMMARY

Many persons are dying unnecessarily from cancer because of the ignorance of the public and within the medical profession.

Many of these could be saved or relieved of much of their suffering if funds now supplied for special phases of the problem could be devoted to the problem as a whole.

Funds and effort should be divided between education of the public and profession, supplying facilities for care and treatment, and research, both clinical and laboratory. The size of each fraction must necessarily vary with both place and time.

Team work in the diagnosis and treatment of cancer is an absolute essential.

REFERENCES

(1) Reports submitted by the Radiological Subcommission, Cancer Commission, Health Organization, League of Nations, Geneva, 1929.

(2) H. J. ULLMANN: Necessity for Team Work in Treatment of Cancer, Southwestern Med., February, 1929, XIII, 71.

The X-ray Examination of Called-up Men and Recruits in the Swiss Army. H. E. Walther. Acta Radiol., 1930, XI, Fasc. 4, No. 62, p. 411.

Since 1923, X-ray examination of the called-up men and recruits has been routine in this division. Fluoroscopy is done by an experienced physician, and films are made of the chests of all those with suspicious screen findings. The roentgenograms serve as objective records of the men's conditions. In the period from 1927 to 1929, 20,000 men were examined in this manner, 1 per cent being found to have chronic pulmonary tuberculosis of which they had no symptoms. In recruits who had previously passed several medical examinations, from four to five per thousand were also found to have tuberculosis. Infiltrative lesions in the upper lobes were the commonest, and in half the cases the disease was bilateral.

The author emphasizes the economic advantage in discovering these cases before they enter military service, also the saving of time in the roentgen examination, as compared with the complete physical examination of the chest. He reiterates the general experience that X-ray investigation will disclose many lesions undiscovered on physical examination. Figures show that practically all the cases of open pulmonary tuberculosis in the Swiss Army occur among recruits from the posts where X-ray examination of the men is not done on entrance into the service.

A. L. HART, M.D.

WHAT SHALL WE TEACH THE PUBLIC IN REGARD TO CANCER AND HOW SHALL WE PRESENT IT?[1]

By D. T. QUIGLEY, M.D., F.A.C.S., OMAHA, NEBRASKA

THE prevention of any disease depends on an understanding of the factors which have produced it. These factors may be single or multiple, specific or non-specific. They may lead to one individual specific factor, as in tetanus, diphtheria, or syphilis, or they may involve several etiological factors, as in cystitis, tonsillitis, or pneumonia.

One of the outstanding points in most of the studies which have been made on cancer is that most of the men engaged in this research seem to base their work on a preconceived idea, and to assume that there is one specific etiological factor for this disease, and that eventually this one specific etiological factor will be discovered. Some of the workers in this field have gone a step farther and have assumed that the etiological factor, when found, must of necessity be a living organism. Others have gone farther yet and assumed that, once the organism is found, an antitoxin will be elaborated which will cure all—even advanced—cases by the simple method of injecting it into the afflicted body.

For none of these assumptions is there any foundation in fact. No one has any right to assume that the great group of diseases called "cancer" has one specific cause, that the cause is a specific organism, or that any antitoxin is possible. On the contrary, all known facts seem to point in the opposite direction.

During the last twenty years it has been proven that cancer is increasing. With the knowledge of the increase in the incidence of the disease has come a very great interest in the whole question, from the standpoints of prevention and cure. Especially during the last ten years much has been said about prevention, and an active campaign directed to this end has been carried on by the American Society for the Control of Cancer. However, the usual attitude assumed at present is that, since we know no single specific etiological factor, we know nothing about cancer—that there is no prevention and no cure. Many of the men presuming to educate the public in regard to cancer and its prevention preface their remarks by saying, "We know nothing about the cause of the disease, and, as far as scientific knowledge at the present time goes, there is no cure." Such an introduction serves to discredit everything the speaker may later say, causing the listener to lose confidence in the efforts made by so-called scientific medical men along this line, and leaving the door open for him to place his confidence in those who least deserve it. If nothing is known about the causation of the disease, then it would seem that efforts directed toward prevention must be illogical and unproductive of good results. If certain etiological factors are known, then preventive methods may be recommended to the public to the extent of such knowledge.

Etiology in cancer should be expressed in the plural instead of in the singular. There are undoubtedly multiple etiological factors in different anatomical locations, and in various ages, and in both sexes.

Cancer itself is simply an exaggerated defense-reaction on the part of the body in which many new cells are produced. These new cells are apparently the last line of defense thrown out in a losing battle with extrinsic agents. These extrinsic agents are of many kinds and of such a nature as to supply the irritation which, inflicting a certain cell injury, calls out the healing cell-

[1]Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1–5, 1930.

building response. There is a considerable degree of similarity between ordinary healing and cancer growth: the only difference is that in ordinary healing the production of new cells is completely stopped when a sufficient amount of healing has taken place to compensate for the injury done. In cancer, a certain number of new cells are produced in response to a like stimulation, but in this case conditions are such that the stimulation is autonomous and continuous, and cell growth resulting therefrom also becomes autonomous and continuous.

The cell growth which we call cancer is not a well ordered, balanced, well fed, and well nourished group of cells like normal body cells, but a haphazard, badly nourished aggregation of cells, fed by chance and not supplied with nerves. This parasitic aggregation of cells is constantly growing and dying. It contains the very much alive, proliferating, penetrating group that is in the forefront of the neoplastic mass. This invading, proliferating group of cells is very much alive and takes nourishment direct from the tissues invaded. The group of cells that has aged somewhat and has been mechanically pushed a distance into the background by the newborn cells is not enjoying the full tide of life, but is somewhat reduced in vitality, or sickened. In the zone farthest removed from the advancing margin of the malignant growth there is complete necrosis, which harbors the saprophytic micro-organisms which exist in all dead and dying bodily tissues. The cancer, then, is a thing which is actively living and invading at one end and dying at the other end, with cells undergoing all the different degrees of sickness, starvation, and degeneration between these two zones. The advancing and invading end of the growth is accompanied by a round-cell infiltration which ordinarily is interpreted as indicating the presence of micro-organisms. The etiology of the disease seems in every case to be bound up with the presence of some kind of low grade micro-organisms.

In external parts of the body where the disease may be studied, ulceration and local germ invasion may be demonstrated for a definite period of time before actual proliferation of epithelial cells takes place. Sections of glands in the neighborhood of cancerous areas show round-cell infiltration and swelling due to the presence of micro-organisms before any actual cancer transplants become grafted into the glands. It seems that there is sufficient evidence to convince anyone who has had a considerable laboratory and clinical experience that cancer is a thing growing on previously diseased tissue, and that the previously diseased tissue is tissue more or less shot through with irritating micro-organisms, these organisms and their poisonous products being the immediate cause of the cell proliferation.

As different parts of the body harbor different kinds of micro-organisms, we find many different germs acting in different etiologic ways to produce cancer. In the colon, we have the colon bacillus; in the throat, the streptococcus; in the skin, the staphylococcus; in the lung, the pneumococcus, etc. In these areas the wall of new cells probably serves to dam back the flood of invading micro-organisms, and it is probable that the life of the person is extended somewhat beyond what it would be did this exaggerated cell growth not serve to check the germ invasion. It must be remembered that whether the anatomical location be skin, mucous membrane, or gland, a thin layer of gland epithelium or squamous epithelium is all that lies between our internal parts and disaster. On one side of this epithelial layer lies an infected or potentially infected field and on the other side lies the sterile field which may not become infected without serious consequences. If a break occurs in the protective epithelium, micro-organisms immediately enter the deeper tissues, but if the break is immediately repaired by the growth

of new epithelium, no great harm is done. If, however, the epithelial wall is broken down repeatedly in the same place, then the group of cells whose function it is to furnish mechanical protection are stimulated to unlimited reproduction, with the result that we have the wild uninhibited growth of epithelium which we call cancer.

All the facts that we have available on the subject seem to substantiate this idea as to the beginnings of cancer. It is not supported by animal experimentation, but has the backing of a great mass of clinical and laboratory evidence. It is the best possible and most practical hypothesis we have available at the present time, and has potentialities for great good as it involves the eradication of all chronically infected disease foci which may become possible cancer-bearing areas. If every potentially malignant fibroid tumor, lacerated cervix, fistula, fissure, diseased gall bladder, papilloma, adenoma, pigmented mole, hemorrhoid, diseased kidney, appendix, diseased stomach and other chronically diseased organs and areas were properly treated, there would be no harm done and there would be enough work to keep the medical, surgical, and dental professions busy for many years, and cancer incidence and cancer mortality would undoubtedly be influenced for the better.

In all the discussions on prevention of cancer that have so far engaged workers in this field, nothing has been said save that which pertains to the local development of the disease. In no case has any real scientist alluded to any general constitutional condition that might predispose to cancer. However, it is possible that something of this kind must be taken into consideration before practical results are obtained. That some persons are more predisposed to the disease than others can not be denied. This same thing is true of every other disease. In the study of no disease have we been able to know just what this predisposition is, except in a general way in dealing with infections of which we can say that resistance to infection is relatively high or relatively low. Along the line of high or low resistance to infections some actually proven animal work has been done. Infections of the eyes, tonsils, and sinuses are known to occur with mathematical certainty in animals that receive inadequate quantities of Vitamin A. Diseases of the nervous system and brain are known to afflict with very great certainty animals that do not receive enough Vitamin B. There is some well founded evidence to the effect that beri-beri and pellagra are infections on a deficiency basis. Infections of the teeth and mouth and other manifestations of scurvy are known to be associated with Vitamin C deficiency. Starvation for Vitamin D or lack of sunshine is definitely known to make the victim more susceptible to rickets and to infection with tuberculosis. A deficiency of Vitamin E is known to be associated with various forms of secondary anemia, and some at least of these, we may presume, are on an infective basis. Deficiency in iodine may bring about low grade metaplastic changes in the thyroid gland. Simple goiters carrying a small percentage of thyroid cancer may be produced in fish by keeping them in water which is deficient in iodine and which contains a relatively high percentage of the fishes' excretions. Deficiency in iron and copper may also produce a secondary anemia which reduces general resistance to infections. Deficiency of hydrochloric acid in the stomach may lead to the infection of the mucous membrane of the stomach and intestines with low grade micro-organisms.

It may be accepted as definitely proven that general or local resistance to infections may be reduced very much below normal by certain food and mineral deficiencies, or kept high by supplying the necessary food elements.

If cancer grows on old, chronic infections and if such infections are aided and assisted by certain food deficiencies, then these de-

ficiencies may indirectly act as predisposing causes of cancer, and it becomes evident that we must consider not only local but constitutional factors in the etiology of the disease.

Cancer may well be compared with other chronic diseases. In all of the well known ones it is universally acknowledged that nothing can be done for the patient in the way of cure if the disease is attacked in the advanced stage. In most of these diseases something of benefit to the patient may be done if the condition is discovered and treated sufficiently early. In our dealings with cancer we have thought only of some kind of treatment of the disease which would effect a cure of the advanced case. Nothing like this is expected in connection with any other chronic disease. The only reason why we have been expecting more in connection with cancer is because our lack of knowledge of this disease has been greater. Knowing little about it, we have expected the impossible. Much wealth and energy have been expended in the search for a magic cure for advanced cancer. We should now realize that the only way in which the situation can be handled successfully is through taking into account both local and constitutional factors and discovering and treating the disease in the stages before it has become advanced. In this connection we will be using the same line of reasoning that we use in handling the other chronic diseases. Cancer should be considered a chronic disease, and no more pessimistic outlook should be the rule in regard to cancer than with any other chronic disease.

In clearing the ground for progress the first thing that should be done is to disabuse the minds of medical men and the public in regard to magic "shot in the arm" cures. The things that have been expected of these cures in the field of cancer have never been accomplished in connection with any other disease; in other words, no disease is cured in its advanced stages. With what evidence we have on the subject, the injection of metals, gland extracts, vaccines, antitoxins, or the "witches' broth" described in "Macbeth" are all equally childish and unscientific. The many claims which have stirred up considerable interest in recent years have all been shown to be without merit, although the promoters furnished what was apparently, at the time, some kind of scientific proof to sustain their theories.

As cancer cells are simply a multiplication of body cells, it is unreasonable to expect that any chemical substance will kill the one group of cells and spare the other. There is not only no hope for a solution of the problem along this line, but it is also evident that such a solution would not be to the best interests of the human race. Much more good is possible in prevention of the disease than in the cure of the advanced case.

Apparently the only bearing that heredity has on the situation is in the hereditary transmission of susceptibility to certain irritants. I believe it is fairly well established that a susceptibility to aniline dyes may result in cancer of the urinary bladder, and a susceptibility to certain other factors in the shape of chemical irritants or micro-organisms undoubtedly exists, in the same way showing a selective affinity for certain other parts of the body.

In addition to clearing the public mind of its misapprehensions in regard to a magic cure for cancer, we should do everything possible to change that point of view which assumes that we know nothing whatever about the disease or its causation. A greater confidence will be established if we assert that we do know something about the causation of the disease. The fact that we know no one specific cause should not obstruct the truth in this connection, and the error should be explained by the statement that we do know many causes of the disease. As fire may be produced in many different ways, and inflammation may be produced in

many different ways, so cancer may be produced in many different ways.

Cancer is known to grow commonly in scars, but practically never do we find cancer growing in a scar when the wound has healed by first intention. Cancer-producing scars are always those which have been infected, and in which incomplete healing has taken place by a slow process of granulation. There are many appendiceal scars, but cancer does not grow in such scars. Ulcers are known to be productive of cancer; yet in a normal, healthy individual ulcers have a tendency to heal, and in such ulcer scars there is no cancer growth. The ulcer which goes on to cancer-formation is an ulcer which has sustained repeated local insult, or exists in a person whose regenerative powers are so much below par that complete and satisfactory healing does not take place. Cancer is sometimes known to exist in persons apparently in a high state of physical good health. Here the local insult is present in such a marked degree that the disease develops in spite of good bodily health. Examples of this may be seen in some cases of cancer of the lip. On the other hand, the constitutional vitality of the individual may be low, inviting hematogenous dissemination of micro-organisms. Examples of this condition are the cancerous masses often seen in half-sick, anemic, semi-invalid, middle-aged persons, the disease attacking large complex glands like the breast in women and the prostate in men.

Jagged teeth cause cancer of the tongue, it is true, but they do so far more often in persons who are syphilitic. The irritation which causes cancer of the tongue in the syphilitic person is evidently seldom capable of producing the disease in one who is non-syphilitic. Local hygiene and constitutional hygiene both enter into the problem of prevention. The getting of this fact over to the rank and file of the medical profession and to the public is one of the most important things in the whole problem.

At this time the ideas held by the general practitioners in regard to cancer are very different from the ideas held by men who have had a chance to make a special study of the disease. Among the ranks of the surgeons there is, again, a very different aspect toward the disease. The surgeon is "sold on the idea" that there is nothing to be done for cancer except through surgery. The general practitioner has seen a sufficient number of surgical failures to convince him that surgery is not the answer to the question. Knowing no other means of combating the disease he becomes confused and pessimistic. The fault with the general practitioner is that he recognizes nothing as cancer until it has become advanced to that condition where it might be diagnosed by the average layman. Even then, to make matters worse, he insists on taking a piece out for microscopic examination. This clinches the diagnosis—and may spread the disease, as traumatism of any kind does —disseminate cancer.

In the United States about a hundred thousand persons die from cancer every year. In the same area there are about a hundred and fifty thousand doctors. If those persons who come to their death through cancer were evenly divided among the doctors of the country, there would be less than one case per doctor per year. This gives too small an actual contact with the disease for the average doctor ever to learn much from actual clinical experience.

In cancer clinics, such as the Memorial Hospital in New York and the State Hospital for Cancer in Buffalo, there are trained men who are capable of recognizing the disease in its earliest stages, because they have had abundant clinical and laboratory experience. These men have little opportunity to see the ordinary patient while the disease is early: the person who does have the opportunity is the general practitioner or family doctor. At present he is incompetent to give

the best service in this connection that modern science has to offer.

Within the last few years cancer cases have been appearing in increasing numbers in the practice of radiologists, cases which are usually treated and studied over a period of years. Many of them are advanced cases and have been subjected to other treatments, but some are early cases. This has given the radiologists an advantage not enjoyed by any other class of physicians. As all kinds of cases present themselves and the period of study is relatively long in the individual case, we may say to-day with assurance that the radiologists are in a better position to know what has already been discovered about cancer, and in a better position to impart this information to the other physician and to the public, than any other group. The experienced radiologist may speak quite definitely of cure in certain localized malignant conditions. We know, for instance, that localized lymphosarcoma and localized small round-cell sarcomas in children may be cured by proper X-ray treatment. We may just as definitely say that any localized accessible cancer may be cured by the application of a sufficient dose of radium radiation. In either case the cure is just as certain as the putting out of fire by the application of water. A little water will not put out a big fire, and a large amount of water on a small fire may make the water more destructive than the fire. Radium therapy and X-ray radiation in early localized cancer are entirely satisfactory in the hands of those who are experienced in their use and experienced in the diagnosis of the conditions which they presume to treat.

Those who have had a large clinical experience and sufficient laboratory knowledge may agree on certain known facts: first, that the formation of cancer depends on certain local irritations which may be mechanical, chemical, thermal, or infective. There is sufficient evidence to prove that cancer always grows on previously diseased tissue, the words "previously diseased" in this connection meaning tissue which is harboring low grade micro-organisms. The constant association of cancer with low grade infections seems to justify the assumption that an etiologic relationship exists. Many infections exist in poorly nourished, overworked, badly housed individuals that could not exist in persons enjoying maximum good health. Bad living conditions and deficient food predispose to the continuance of old chronic low grade infections. Infections of this kind predispose to cancer.

It is quite widely accepted that many benign tumors may take on malignant change. Benign tumors are known to harbor low grade micro-organisms, as old scars in wounds that have healed by slow granulation are known to harbor low grade micro-organisms. Out of many benign tumors, ulcers, and chronic infections, there may develop a few cancers. The removal of etiology in such cases, before the actual development of cancer, is sufficient to cure the patient. After the early local or superficial cancer has developed, the disease is usually curable, but is usually not cured, because of inadequate treatment. At a later stage we have the local cancer existing, with small cancer particles already present in the surrounding lymph vessels. The cancer is still curable. At a little later stage particles that have become separated from the main mass and have been carried into the neighboring glands have started secondary growths. The problem of curing the patient is now as hopeless as is the task of growing a new leg on a person who has had his leg amputated. The patient with metastatic cancer is and apparently always will be an incurable patient. The patient has arrived at this unhappy stage because of neglect or inadequate treatment in the earlier stages. Many danger signals have been passed unheeded, and to address ourselves to the problem of curing the patient in this unfortunate condi-

tion is as unreasonable as to attempt the rehabilitation of the engineer after he has passed red lights on the railroad. In the case of the engineer we would consider it more logical to insist on care in observing the danger signals. In the case of the cancer patient the problem must be handled the same way. Not the medieval idea of a magic cure after irreparable damage has been done, but the common-sense use of known facts in prevention and in the cure of the early case.

The local injuries which are commonly known to be pre-cancerous might well engage the attention of the medical profession. The ulcers, the leukoplakia, the jagged teeth in the mouth, the strictures in the esophagus, the ulcers in the stomach and duodenum, the old chronically infected stone-bearing gall bladders and kidneys, the localized and generalized colitis, the papillomatosis and diverticulitis of the colon, the rectal ulcers, hemorrhoids, fissures and fistulæ, the old chronic infections in the prostate, the papillomas in the urinary bladder, the lacerations and ulcers of the uterine cervix, the malignant change in so-called fibroid tumors of the uterus, the malignant degeneration of previously benign ovarian cysts, the malignant degeneration occurring in previously benign adenomas and cysts of the mammary gland, these and many other well known pathological conditions may, if properly subjected to intelligent medical or surgical treatment, satisfactorily head off the development of malignant disease. A good many of these local conditions could not exist in a person or an animal with a high degree of resistance against infection. The laceration of the cervix which in the civilized woman leads eventually to death from uterine cancer probably occurs also in the Indian woman who does not have cancer. In the former, the healing is not complete and satisfactory, due to constitutional causes, and in the latter it is satisfactorily taken care of because healing power is high. The same thing may be said in regard to the animals. The animals of the fields are practically free from cancer. The animals that live more nearly like humans have a higher incidence of cancer, the highest animal cancer incidence being in dogs, that live more nearly like humans than do any other animals, and that eat the deficient food which constitutes the leavings from the tables of human beings. Dogs that live more completely on the same foods as humans have a greater incidence also of colds, influenza, tooth decay, pyorrhea, paralysis and other nerve diseases. The more highly bred and carefully cared for are most subject to these diseases.

In conclusion, we may state that the etiologic factors in cancer are multiple, that the disease—like tuberculosis—is the result of localized injury and unhygienic living. It involves both local and constitutional factors. The almost constant association of chronic infections with cancer makes it evident that an etiologic relationship exists and that the invading micro-organisms and their toxins act as growth-promoting cell irritants. If this explanation be accepted, the etiologic factors in cancer become as plainly apparent as the etiologic factors in any other chronic disease.

The search for a cure for advanced cancer has led to misconceptions and aroused a false attitude toward the disease in the minds of both the public and physicians. To the person who has had a considerable clinical and laboratory experience in cancer, the magic cure idea for the advanced case seems futile and unreasonable. The successful solution of the problem can not be accomplished by this method of approach.

The group in the medical profession that is best fitted by experience and training to teach the public and the profession in this connection is that ordinarily designated as radiologists. The education and publicity committees of the Radiological Society of North America and the American Radium Society and other leading radiological

societies could well formulate a pronouncement on cancer to be given to the public through the usual channels which would do more toward the real understanding and solution of the problem than anything heretofore done along this line in the history of civilization. Such a beginning, properly directed, is capable of leading to a change in the understanding of the disease which might have much to do with the eventual control of cancer.

DISCUSSION

HENRY SCHMITZ, M.D. (Chicago): A knowledge of the direct or true cause of cancer is desirable but may not aid us in finding a specific cure. In illustration of this I may refer to tuberculosis; since we have known the specific cause of tuberculosis, we really have not advanced very much farther in its treatment. Whatever benefits have been derived have come solely through the clinical study of the disease and by early diagnosis and adequate care. At present, the cure of cancer consists in the application of surgery, irradiation, and electric coagulation—the latter, being purely surgical methods, should be included in the former.

Regarding the question of early diagnosis, I have always doubted whether or not the money spent on the education of the public in order to make it cancer conscious was well spent, or whether it would not be very much wiser to spend this money in the medical profession to educate it in the early recognition of cancer. As soon as we have organized all the facilities for the diagnosis and adequate treatment of these patients, let us invite the public to see what we can achieve. If we begin to recognize carcinoma in the beginning stage, from 80 to 90 per cent of all carcinoma sufferers may be cured. The reason so many die from cancer is that they are brought to us at a time when they are purely and simply incurable and hopeless.

Cancer should be treated by a group of men who are specialists in the study of cancerous disease and who are especially trained in surgery and irradiation of carcinoma. There is a vast difference between a standard operation like appendectomy or mammectomy and a radical operation that must be performed in surgery of cancer in these particular regions. The condition in radiation therapy is similar. If we know the extent of a cancer in a given organ or region of the body, then irradiate the tumor-bearing area adequately, results should improve. A fixed cancer, a pelvic cancer extending beyond the limits of the true pelvic cavity, a breast cancer extending above the clavicle or into the mediastinum, are, as a rule, generalized cancers and cannot be arrested by any except the most radical method of treatment.

A group of men should be formed in each general hospital for the study, diagnosis, and treatment of malignant disease. The group should include an internist, a surgeon, an X-ray diagnostician, a radiologist trained especially in the radiation treatment of cancer, and a pathologist trained not only in general pathology but particularly in tumor pathology. If the cancer situation were handled as suggested by Dr. Quigley and Dr. Ullmann, and if the cancer specialists were to co-operate with the American Society for the Control of Cancer to induce them to assist in the organization of the medical profession in existing general hospitals, and to consult with the general practitioner and even the general surgeon in early recognition of carcinoma, and in adequate treatment, improvement in the control of cancer would be immediate.

ROLLIN H. STEVENS, M.D. (Detroit): As Dr. Schmitz has said so many things that I wanted to say, I am not going to try

to repeat any of them because he has said them so much better than I can. I want, however, to emphasize one point, and that is the great necessity of training men in the different specialties for the diagnosis and treatment of cancer—only such practitioners should be entrusted with the treatment of cancer. Such training of the specialist and education of the general practitioner are more important than the attempts to educate the public on subjects on which we have so little accurate information. False notions that I think are really harmful have been taught people in these cancer campaigns by physicians who have but little knowledge of the subject. We have had to take back many so-called "facts" that have been taught the public in these campaigns. If we, as radiologists, would keep in touch with the latest developments in cancer, develop and take part in clinics where patients would be examined and treated along the lines that are being gradually developed, and do what we can to educate other physicians, who, in turn, would look after their patients' interests, more would be accomplished than by spending so much time with the public, which hears so much it becomes cancerphobic.

JAMES M. MARTIN, M.D. (Dallas, Texas): First, I want to indorse all that the Doctor has said and emphasize it, if possible. The lack of specific knowledge of cancer by the rank and file of the profession is pathetic. The specialists doing eye, ear, and nose work frequently treat cancer of the face, sinuses, etc., by temporizing methods, until the disease has passed beyond hope of a cure by any method. In our section of the country we seldom see cancer of the sinuses in the early stage. I would like to indorse the idea now being emphasized by the American Society for the Control of Cancer, namely, "educate the doctor first and, through him, the public."

DR. R. N. DELITCH (Pasadena, California): In Paris, in five years, the progress in the treatment of cancer by radium has shown from 34 per cent to 72 per cent gain —nearly double, or, more exactly—

(1) In 1919, of the total number of cancer cases treated by radium, only 34 per cent were found alive one year after the treatment.

(2) In 1925, of the total number of cancer cases treated by radium, 72 per cent were found alive one year after the treatment—nearly double.

Some specialists think that this progress is due to the better technic and better professional education. I really think that it is due, as well, to the education of the public and the better organization of the cancer propaganda.

I started to learn something about cancer with Professor Cerny, in Heidelberg, in 1911, and later, for about six years, in Paris with Professor H. Hartmann, who put me in charge of a cancer dispensary at a Montmartre institution which was not for the people going to Montmartre for a good time but for the poor people suffering and having hard times in that famous Paris district.

In my Montmartre dispensary or in a larger cancer hospital center, I had occasion to see some hopeless, incurable cancer cases coming late to the right cancer institution—coming late because they had been treated in some private office. For example, some cancers of the uterus had been treated as metritis, or some cancers of the rectum as hemorrhoids, and this not due to professional ignorance but for personal profits, sending those poor patients late to the cancer centers when there was no more hope for cure. In so doing, certain physicians were treating those cancer cases as if they were silver or gold mines, for the longer the time and the more often that those patients came to the physician's office and paid for the visits, the better it was for his

income. This is absolutely wrong: it is criminal to treat these patients so.

For this reason public education is as important as professional education. If, in Paris, we now have 72 per cent of patients alive one year after treatment, instead of the former 34 per cent (in 1919), it is due to public as well as to professional education. Thanks to cancer propaganda, persons come sooner for treatment and know the right place to come. We have in Paris, as you have certainly here, some wonderful nurses and volunteer workers. They used to go to the public markets, schools, and poor districts to teach the people how horrible is the death by cancer, cancerphobia being one of the best agents for cancer cure. For all these reasons, it would seem advisable to print special lists of recognized cancer centers, to save the people from charlatanry and commercial clinics where personal profit comes first and the patient's health last.

DR. J. E. GENDREAU (Montreal, Canada): I wish to recall what the American College of Surgeons has recently done on this subject of cancer. They have established a special committee for surveying and classifying the institutions that are working on the cancer problem: cancer institutes, cancer laboratories, cancer hospitals, general hospitals in which cancer is specially treated, and diagnostic clinics. They propose to consider as "Class A Hospitals" only those hospitals in which there is a special cancer clinic.

I think it is a very important step, for the radiologists should consider the part they have to play in a general organization for the control of cancer. Recently, in some countries the surgeons have assumed the entire selection of different groups of men who are called upon to treat cancer. It seems to me that the radiologists should join with the surgeons to help one another, under the guidance of the best men in a given center, surgeons, radiologists, pathologists, and general physicians. The direction of cancer treatment depends upon a group and in this group the radiologist is awarded the prominent position in many cases.

A. R. KILGORE, M.D. (San Francisco, Calif.): It does not seem to me that what the Society for the Control of Cancer has attempted to teach the public has been to any degree untrue. I think perhaps the Doctor has been reading the articles carried in the daily press by certain self-appointed guardians of the public health. The only thing we have had to take back has been our statement of five or ten years ago that cancer was known not to be hereditary.

But I do think we have to admit that the campaign which has been carried on by the American Society has gone somewhat stale. It has gone stale because we have not anything new to offer, and it is extremely difficult to secure effective publicity, as any one knows who has tried to do so, unless he has news to offer. I think the campaign of past years has been, on the contrary, quite successful, and the very reason why you are hearing the problem of the necessity of educating physicians discussed to-day so much is because the campaign, as carried on, has brought so many more patients early. The American Society has recognized the fact that its campaign had to be carried on along different lines, and I think I may state for the Society that its plans for the future agree with the ideas expressed here to-day—that our work both in educating the profession and in educating the public must be carried on definitely on the basis and with the help of cancer institutions—the group treatment of cancer. It is quite true that our medical schools have failed lamentably in training the profession for the diagnosis of early cancer and its treatment. When I graduated, not so many years ago, from a very fair medical school, I did not know the difference between a carcinoma and an ingrowing toe nail except

by name. We are trying our best to change that at the University of California. We feel that if we do not see to it that when our students leave us they know what the problem of an early breast lump is, their education will have been incomplete; and we are going to do that easier if we can follow up improved training in the medical schools with post-graduate training centered in cancer institutions.

ROLLIN H. STEVENS, M.D. (Detroit): I do not want you to understand that what I said about publicity was in criticism of the Society for the Control of Cancer. What I referred to was the information as given out by untrained doctors who know but little about cancer and who were appointed as lecturers in cancer campaigns to impart knowledge of cancer to the public. They certainly have given out a lot of misinformation about heredity and the surgical treatment of cancer. We have to modify our views on the subject of cancer from time to time. The public is not so much concerned with undemonstrated theories as with facts; *i.e.*, it is confused by such statements as, for instance, "Surgery is the only cure for cancer and, if taken early enough, all—or the greater proportion of—cases can be cured by this method," made to-day, while to-morrow that statement may be modified by one which says that cancers are probably not thus cured, and that X-ray and radium will do much better work in certain cases.

DR. ULLMANN (closing): I think this discussion has brought out the necessity of meeting the cancer situation as I have outlined, *i.e.*, money for the cancer problem should be used for the problem as the whole. In one locality the public must be educated, in another the physicians, in another facilities must be furnished. What good does it do to have physicians who know how to treat cancer and patients who know enough to go to them, if there is nothing to treat these patients with when they get to the hospitals? The term "facilities" includes free beds for indigent patients. In closing I shall repeat what I said in my paper "The Necessity for Teamwork in the Treatment of Cancer," and what was so well brought out by Dr. Schmitz, that the problem of cancer can be met only by the trilogy of the surgeon, the radiologist, and the internist, placed equidistant from the pathologist as the center.

DR. QUIGLEY (closing): There is not much to be said in closing except to agree heartily with what Dr. Schmitz has said. I am sure he has "hit the nail on the head" when he says that those vast sums of money which have been expended in cancer research would have been much better spent on the education of physicians rather than in the effort to try to educate the public.

CASE REPORTS AND NEW DEVICES

FATAL RESULT FROM USE OF UROSELECTAN

By J. A. RIEBEL, M.D., and FRANK A. RIEBEL, M.D.

COLUMBUS, OHIO

Inasmuch as the literature to date indicates that intravenous pyelography is a harmless procedure, we feel it timely to present a case in which we feel that its use contributed to the death of a patient.

A. C., a white male, aged 53, was first seen by us on November 15, 1930. He gave a history of diabetes, and for two months had had a series of furuncles. Apparently both the diabetes and the furuncles had received indifferent treatment. For the past two weeks he had been running a fever, and had lost twenty pounds in weight.

Examination on the following day disclosed an obese white male, apparently quite ill. Temperature, 104°; pulse, 130; respirations, 28. There was a large furuncle over the seventh left rib, and another over the right kidney. Palpation gave a sense of resistance over the latter area, although a mass could not be definitely outlined.

X-ray examination of the chest was negative. Roentgenograms of the kidneys revealed moderate uniform enlargement of the left kidney; the right one was not visualized. However, while the lateral margin of the left psoas muscle was well defined, that on the right was very faintly visualized and appeared compressed medially. The lumbar spine was flexed to the left; diagnosis of probable perinephritic abscess was made.

Cystoscopy was performed, but because of intense inflammation, the ureters could not be located. As we had administered uroselectan in three cases previously in our series without untoward effects, and as the diagnosis was still in some doubt, this procedure was thought to be indicated. We, therefore, injected two-thirds of the normal dose of uroselectan at 2 P. M. Forty-five minutes later the patient had a severe chill, and the temperature rose to 105°; pulse, 160 and weak. At the same time he became wholly incontinent. At 3 P. M. a roentgenogram disclosed the presence of a little of the opaque drug in the bladder, but its concentration was insufficient to produce a pyelogram. A blood count showed: red blood cells, 4,510,000; white blood cells, 18,475; hemoglobin 75 per cent. No urine was secured because of the incontinence. The patient lapsed into unconsciousness at 5 P. M. As it was feared that he would not react, he was operated upon at 7 P. M. An incision in the lumbar region over the right kidney disclosed an abscess containing two liters of thick pus, superficial to the muscles. A second incision released another liter from the region of the left midaxillary line. At 11 P. M. the temperature reached 107.8°, with no pulse. At 2 A. M. the patient died.

SUMMARY

A case is reported in which the death of a patient, previously weakened by infection, was hastened by the use of uroselectan.

The case is interesting further in that the classical roentgenological signs of perinephritic abscess—lateral flexion of the lumbar spine, and unilateral effacement of the lateral margin of the psoas muscle—were simulated by an abscess located superficial to the muscular layers.

ELIMINATION OF THE DARK ROOM IN PHOTOGRAPHY, ESPECIALLY AS APPLIED TO ROENTGENOLOGY

By H. FLECKER, M.B., F.R.C.S.,
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One becomes so accustomed to the disadvantages of dark rooms that they do not attract much attention, yet it is a fact that the actual necessity for such dark rooms, together with the necessary equipment, has deterred many medical men and dentists from installing X-ray apparatus. The dark room itself may have to be especially built or designed and this in itself implies added cost or additional rent. To avoid this, one frequently finds all sorts of places pressed into service as dark rooms, such as cupboards, cellars, attics, pantries, bathrooms, perhaps unsanitary and dirty and otherwise objectionable. Such makeshifts can be seen in every city and are extremely common in the country.

Rendering the dark room light-proof is frequently an expensive item, necessitating special blinds and curtains, ordinary window blinds being, of course, quite inadequate. Crevices, key-holes, ventilators, and other sources of light must be adequately covered, and to make the room light-proof there may be interference with proper ventilation. Of course, inadequate exclusion of light results in fogged films. To prevent accidental entry of light it is usual to lock the door during developing operations; in busy laboratories, expensive labyrinthine or revolving doors are fitted. As a rule, no outside person can gain admission to the dark room during the processes of developing or changing films, and thus it may be particularly inconvenient when stores, records, and other items are kept in the room.

It very rarely happens that owners are proud of the appearance of their dark rooms. The heterogeneous collection of tanks, bottles of chemicals, fixed cupboards, film hangers, and various other items does not make an attractive sight, whilst much of the dark room equipment is fixed and immovable, involving considerable expense if one is required to move to another location.

The menace to health of dark room operators is quite considerable owing to unhealthy surroundings, exclusion of light, and often inadequate ventilation. Rarely are special exhaust fans fitted as they involve additional expense, whilst cold floors and inadequate artificial heating also constitute disadvantages. Special acid-resisting flooring without any floor cloth is particularly cold in wintertime. It is, of course, quite impracticable to utilize electric radiators or the like.

Unless an expensive drying mechanism is installed, it takes many hours, especially in cold weather, for films to dry, and often films developed one day are not dry until the next.

All the various disadvantages just described have been overcome, and an apparatus has been built to eliminate the disabilities enumerated. A description of one model will serve as a type. The various parts may be noted in the illustration (Fig. 1).

The outside appearance shows the panels in the center above to consist of two doors, hinged on either side. On the right is the detachable drying chamber. Above, in addition to the switches for view lights and heater for the developing tank, are switches also for the drying compartment and a special heater for heating the tank compartment. A timer is placed on top of the cabinet.

The drying apparatus is on the right and is detachable. Above, a door connects it with the operating chamber. Suspended be-

neath the ceiling is a rack which can be pulled into the main operating compartment to receive the hangers after washing and viewing. When dried, the rack can be withdrawn by a door on the right-hand side of the cabinet. In the lower part of the cabinet is a special arrangement for drying the films by means of hot air. In the standard models designed, not only is the drying cupboard detachable, but also the hanger magazine and film store on the left. The operator, therefore, may install the central part alone, and at a later date add the drying cupboard as well as the hanger magazine and film store, as desired. The magazines for cassettes and films may be added separately, while the less elaborate tanks originally provided may be exchanged for more elaborate tanks, at any time.

Much care has been devoted to the design of the operating sleeves, which are perfectly light-tight, elastic, allow of the entry of the forearms with the greatest of ease, and permit of ready access to every part of the operating chamber. Any prejudice which may be conceived against their practicability is immediately dispelled upon examination. With the working slide in its normal position over the film magazine and the drip tray over the tank, there is no risk of fogging the films by light entering through the apertures of the sleeves when the forearms are not inserted.

When the sleeve panel doors are swung out, the interior of the cabinet is exposed. At the back are the rack and view box. On the left is the hanger magazine, divided into separate compartments of different sizes arranged horizontally to accommodate the various sizes of hangers. If desired, the magazine may be pulled farther into the working chamber.

On the floor of the operating chamber is the working slide, which slides either to the right or left. In its normal position it covers the cassette and film magazines, but to uncover these parts, it can be moved either to the left beneath the hanger magazine or to the right over the developing tanks. Its lower surface is covered with lead to prevent stray X-rays reaching the films in the magazines. It serves as a work bench during the various loading and unloading operations and also preparatory to placing the films in the developing solution. Below, on the left, is a lead-lined cupboard for unopened film boxes, etc. In the middle, beneath the working slide, are two separate compartments. On the left is the magazine for the cassettes, divided into separate compartments of different sizes, arranged so that the cassettes may be inserted from without, in front, and removed from the interior of the chamber during working operations. The film magazine is situated immediately to the right of the cassette magazine and is similarly divided into separate compartments for films of different sizes. The spare space at the back serves as a chute for surplus wrappings and other papers, which are collected below in a special receptacle.

The whole unit is designed for use with special hangers which constitute a considerable improvement on those in current use. Much time is saved, as the films are slid into the hangers by a single movement without the necessity of clipping the four corners. The films do not bulge in the solutions, are just as easily removed by a single movement, and the hangers are specially designed to facilitate drying around the edges of the films.

The tanks are, in order from left to right, for (*a*) developing, (*b*) rinsing, (*c*) fixing, and (*d*) washing. All tanks (except the rinsing tank) are fitted with special guideways so as to provide the maximum accommodation for the films without the risk of abrasion, thus greatly economizing the photographic chemicals. Each tank is provided with a special pipe to which is fitted an ar-

rangement for maintaining the solutions at a fixed level. The developing tank is provided with a heating device and an automatic solution agitator, as well as, when desired, a device for the automatic regulation of temperature. There is also means for its automatic filling and emptying. The washing tank is provided with inflow pipe at the bottom as well as outflow, to permit of the use of running water. In addition, an arrangement is provided for heating the whole of the tank compartment. Over the tops of the tanks is fitted a drip tray to allow the water to flow back into the washing tank.

Variations of the above have been made, according to the type or volume of work to be carried out. For instance, a design has been evolved for dental work, as well as a portable model. In addition to these, another model comprising the advantages of the tanks has been constructed for use in an already established dark room. One improvement deals with dental films, introducing the dental till as well as an entirely new type of dental hanger. The former is a small box divided into fourteen compartments, seven for the upper teeth and seven for the lower. The dental films themselves



Fig. 1. Interior of cabinet exposed. Above is white viewing light behind and hanger magazine on left. Below are lead-lined film store, cassette magazine, film magazine, paper chute, and tanks.

are marked with the letter "L." The vertical and horizontal limbs lie parallel to one long and one short side of the film. When the exposure is made, care is taken to see that one short or long limb is applied to the edge of the teeth, thus indicating which is the edge of the tooth in the film. As each film is exposed, it is placed in proper serial order in the till. The dental hanger is built up in the same way as ordinary dental mounts, that is, of a series of spaces, seven in a row, four rows (one row for top set and one row for lower set of teeth, both repeated for duplicates). Prior to development, each film is taken out of the till in its proper order, and mounted in its proper place in the hanger, with the free edge of the teeth downwards in the upper set and upwards in the lower set. After the films are developed and fixed they may be immediately viewed before the view box. There is no necessity to wait until the films are dried. The time-absorbing process of sorting is likewise abolished, as the films are already in proper order and may be at once placed in front of the view box for inspection.

To sum up, the entire system of dark room procedure may be revolutionized by this new unit. As yet, no operator who has worked with one prefers to revert to the old dark room methods, and X-ray departments in Australia are being designed entirely without dark rooms.

The units described have been designed and patented by Mr. John Bowker, of Melbourne, Australia, to whom the writer is indebted for the illustration.

PRESTON M. HICKEY MEMORIAL LIBRARY

Soon after the death of Dr. Preston M. Hickey a movement was started to establish some sort of a memorial to this leader in the field of roentgenology. After due deliberation the idea of a "Preston M. Hickey Memorial Library" was considered most feasible.

As Dr. Hickey had in his last years developed an organization for post-graduate training in roentgenology at the University Hospital, Ann Arbor, that department has been selected as the location for such a library.

Mr. W. W. Bishop, Librarian of the University, will accept and combine such a collection of books with the Medical Section of the general library, have them catalogued and listed and maintain an exchange in case of duplication. This can be done and still allow the library to be within the Department of Roentgenology for use of the staff and students. Dr. Hickey had hoped to establish such a reference library.

The men trained under Dr. Hickey and those of his colleagues who know of the plans have signified their willingness to donate one or more volumes to this project. I am writing this letter in order that you may give it editorial comment if you so desire.

We feel that there are numerous friends of Dr. Hickey who would like to join in this effort but it would be rather difficult to reach them except through the medium of radiological publications. We are sending a letter to the Editor of each journal and asking that if he mentions the attempt which is being made in behalf of this memorial that he request any one who cares to donate to communicate with Mr. W. W. Bishop, Librarian at the University of Michigan, Ann Arbor.

[Signed] S. W. DONALDSON, M.D.

EDITORIAL

M. J. HUBENY, M.D. . . . . *Editor*
BENJAMIN H. ORNDOFF, M.D. . *Associate Editor*

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ANACHRONISTIC APHORISMS[1]

A beguiling and intriguing title, but so is the subject matter of this essay.

As a member of the infant Section, kaleidoscopic events have bewildered me in the same manner that others have been confused, annoyed, and somewhat paralyzed, because of the rapid changes affecting the humanities.

A well balanced life consists of a little bit of work, a little bit of play, and a little bit of sleep, and this philosophy is not the exclusive property of any given class or creed.

Medical men, as a whole, are self-sacrificing and unappreciated; usually their families are penalized by society because the breadwinner does not win enough of the material things to let them live in reasonable comfort, not to say luxury.

A new order of things has taken place; conditions and times are changing. Two factors have produced a somewhat sudden transition, creating a whirlpool which has engulfed pretty much the whole world. One has been the World War, which for a while produced an economic disaster—I say disaster because, in the ordinary course of events, the terrific economic adjustments which are now taking place would not have occurred during the period of a dozen generations, yet they are now crowded into the short span of one or two generations. It is true that eventually great economies will be effected; however, they have come so rapidly as to be actual cataclysms.

The other factor in these changing times is the so-called mechanization, which has liberated man-power from the most irksome, fatiguing, and depleting forms of employment. Mechanization in its finer sense includes the sciences; it explains rather tangibly what yesterday was considered metaphysical.

The basic sciences have established themselves firmly in routine medical work. The clinical thermometer and the stethoscope are accepted as quite necessary appliances. These simple tools have been rapidly aligned with intricate microscopes, spectroscopes, chemical apparatus, metabolimeters, electrocardiographs, and X-ray apparatus. In the final analysis, the aforementioned instruments give certain more or less definite information which, if properly collated, has the greatest value. So you can readily see that individualization still obtains; however, egotism and eccentricities are passé.

It seems incomprehensible that certain types of medical men deplore the use of refined diagnostic measures; however, it is more probable that they have in mind the abuse of these methods, and, to emphasize this, they unwittingly create the idea that inadequacy is the result of mechanization.

This same type of mind bemoans the passing of the family doctor. Well, has he really passed from existence or have we a new type of family doctor? The doctor of to-day is far better grounded in real values because of methods of precision. It is equally true that there is less sentimental at-

[1]Chairman's Address, Section on Radiology, American Medical Association, Portland, Oregon, July 19, 1929.

tachment between doctor and patient; however, the attachment to-day is founded not on the emotional instability of the patient, but on the sounder service rendered to him, for which he is both grateful and appreciative.

So we have to-day the anticipated change in medicine. It has drifted from an eleemosynary institution, with its attendant inadequacy, to a real industry, to a commercial enterprise. In the past, we have resented the term "commercialism," but commercialism is a fair exchange of values at a chronological period of activity, which values are ever-changing and require frequent adjustments.

I am making no attempt to defend dishonest practices or persons—they are not even in the picture. I am of the sincere opinion that while the Hippocratic oath has been the guiding principle of conduct of the medical profession, it is equally true that men or groups of men in other pursuits have similar ideals and motives. There is one great difference which is quite obvious, namely, a violation of morals or conduct which jeopardizes life is the basest of crimes, hence the type of individual taking up medicine must be of the highest order.

Now, as to the cause or causes of the high cost of medical service. To roentgenologists it has become apparent that the day has passed when you can say to John, "Let me see your tongue," then feel his pulse and say, "Well, you'll live a hundred years"—and then John ungraciously drops dead two hours later. Medicine cannot be practised that way, because of laws demanding certain standards of efficiency and because your competitor will wear you out, as he uses or has the assistance of collaborators who use expensive apparatus to obtain certain data.

This naturally implies that a definite expenditure is necessary, and, in the case of those practising radiology, it is surprisingly and unavoidably high, varying from fifty-five to sixty-five cents of every dollar earned.

Time will not permit a comprehensive analysis of this phase, as the ramifications are so wide; however, basically, it costs much to function in accordance with accepted standards.

Reverting back to the Hippocratic oath, there is one flagrant violation—it is a sad one, too, because the oft-practised custom of sending patients to lay technicians for radiological services is indulged in by supposedly honest and efficient physicians. Of course, it is needless to say that this practice is subversive to the best interests of the patient, besides being dishonest.

Roentgenology has in many instances reduced the intangible to the tangible, and, in the performance of this service, ponderous appliances are used, accompanied by a whirring and a buzzing, representing the ultimate in mechanization.

Efficiency is to-day a greater by-word than at any time in history and the medical profession is faced with serious problems, the solutions of which are attempted by lay people, who, properly inspired, make bequests of a religious, social, or medical nature. This is a benignant expression of benefaction. These zealots may be misguided, but sincere. Unfortunately, it often happens that the proper medical co-operation is not extended to guide such a benefaction, and it then acts as a boomerang, both to the medical profession and the benefactor.

One can readily see that medicine is becoming institutional, either as privately endowed, supported by taxation, or privately owned by the doctors themselves or jointly by doctors and lay persons. All such institutions have their sphere of activity and usefulness and should be recognized as permanent social structures with varying modifications.

As prosperity becomes more diffuse, the tax-supported institution will become grad-

ually extinct; pauperism, with its accompanying mendicity and shame, will greatly disappear.

Of course, the time factor is an essential one, and, necessarily, a constant analysis of the changing times is imperative.

Now, who can make this analysis—make it squarely and properly, certainly? Medicine is the hub of all activities and always will be, because life and all its activities pivot on health. This is a duty which could readily be absorbed by the American Medical Association, the parent body. Many of us hardly realize what a gigantic organization it is, or how extensive are the ramifications and numbers of its functions and activities. It consists of about 100,000 members; it publishes nine scientific journals, also a journal for public education in medical matters, namely, "Hygeia." It maintains a chemical laboratory for original work and analysis of nostrums. The Council on Pharmacy and Chemistry investigates and reports on medicines used by physicians. The Council on Medical Education and Hospitals conducts investigations and standardizes colleges and hospitals. The Bureau of Legal Medicine and Legislation does just what its name implies. Another activity is the Bureau of Health and Public Instruction. The good of the people is uppermost. The Department of Publications issues an index of medical literature.

There is nothing incompatible between sentiment and interest and it is only when one of these predominates that oppression begins. Since it is admitted that medicine is an industry, as previously mentioned, therefore, in accordance with the present trend, would it not be desirable for the sake of economic unity to establish another bureau, to be called the Economic Bureau, which would consist of three economists, three politico-economists, three sociologists, three psychologists, three successful commercial appraisers, three statisticians and any other special group of highly trained and experienced men who could command good compensation, and who could analyze what social, economic, and educational changes are taking place and see where medicine fits in the scheme of things so that proper adjustments could be made in accordance with the changing times? In this way a well organized adjustment could be made from time to time without the usual great attendant financial distress.

Certainly medical men have brains and capacity to formulate modes of conduct and business, applicable to medicine, that would be equitable to all.

Of course, such an activity would entail considerable expense, and, to provide for this contingency, the doctors, if properly enlightened, I am sure would cheerfully contribute towards its maintenance.

It appears that there are too many societies—societies that have some real or imaginary reason for their existence. There has been a cleavage in medical activities; the formation of special societies has caused, in some instances, a supercilious attitude. Regardless of the original stimulus, their abolition should take place because of the reduplication of effort, the false expenditure of time and money with the minimum amount of return, and because the American Medical Association, as now constituted, covers all the activities both scientific and educational. Therefore it would be sane and sensible to initiate such a program. The savings thus effected would cheerfully be paid in the form of dues to the American Medical Association for essential activities.

I hope that these remarks will not be construed as iconoclastic or vindictive, but as food for modified thought and action.

PUBLICATION BY THE COMMITTEE ON THE COSTS OF MEDICAL CARE

Publication No. 7 of the valuable studies being issued by the Committee on the Costs of Medical Care is entitled "Capital Investment in Hospitals," and is written by C. Rufus Rorem, Ph.D., C.P.A., of the Research Staff. Under the sub-title, "The Place of 'Fixed Charges' in Hospital Financing and Costs," is the statement that this pamphlet is "a digest from the book, 'The Public's Investment in Hospitals,' published by the University of Chicago Press."

The summary and conclusions are as follows:

"1. Capital investment in the 7,000 hospitals in the United States exceeds three billion dollars, a greater investment than that in many important manufacturing industries.

"2. The average investment-per-hospital is $425,000, an amount usually too great to be provided by individuals or small groups.

"3. Hospitalization requires a capital investment of approximately $5,000 for every patient under treatment for acute diseases or conditions.

"4. Ninety-one per cent of the capital investment has been provided on a non-profit basis in about equal proportions by governments and non-profit associations, respectively.

"5. Only 9 per cent of the capital has been provided on a business basis—through 'proprietary' hospitals—with the expectation of earnings or repayment.

"6. Most hospitals, 4,538, are for 'general' medical and surgical care. They represent 41 per cent of the bed capacity, 60 per cent of the capital investment, and an average investment-per-bed of $5,000.

"7. Two-thirds of the capital invested in general and special hospitals is controlled by independent associations and by churches and religious orders.

"8. Governmental hospitals represent 95 per cent of the capital devoted to the care of persons afflicted with mental disease and 75 per cent of that invested in tuberculosis hospitals.

"9. The state governments have provided most of the 393,737 beds for nervous and mental cases. This capacity exceeds the total in all hospitals for general care, but is concentrated in 553 institutions.

"10. Investment-per-capita in 'general and special' hospitals (other than Federal) is highest, $25, in the North and Middle Atlantic states, and lowest, $6, in the South and South Atlantic states.

"11. Existing endowment capital, 437 millions (mainly concentrated in the few older hospitals in metropolitan areas), if redistributed among all hospitals in the United States would provide but $0.08 per patient-day toward operating costs.

"12. The annual capital expenditures approximate $200,000,000. Much of this total is directed towards replacing and improving hospital facilities rather than expanding bed capacity.

"13. 'Fixed charges' (interest and depreciation on capital investment) are costs of hospital service, although usually met by the general public rather than from patients' fees. They may range from $0.50 to $5 per patient-day, varying with the total investment and the rate of occupancy.

"14. Additional patients can be served at very low additional operating costs, once plant and equipment have been provided and held in readiness for use.

"15. Increased utilization of facilities is one of the major demands of hospital economy and efficiency.

"16. Hospitals generally fail to render a precise accounting for capital investment.

"17. It is probably true that the non-profit basis of providing hospital capital has not most effectively encouraged utilization of the facilities.

"Finally, it seems appropriate to suggest certain broad *conclusions and implications* from the findings of the study:

"I. The public owns the hospitals generally and will probably continue to carry the major burden of the fixed charges. The advantages of hospital facilities accrue in large degree to the entire public; hence the provision of hospital capital by the general public through taxation and voluntary contributions is an equitable procedure.

"II. The public might well exercise better control over the provision of capital investment. This may be accomplished through organized community approval of hospital construction programs, as well as through improved apportionment of patients and kinds of hospital service among existing institutions. Such a policy would release funds for other community purposes.

"III. Capital investment in hospitals should be held to an absolute or relative minimum consistent with effective medical practice. Such investment cannot be withdrawn for other purposes, nor is it desirable to restrict plant and equipment in such manner as to reduce the quality or amount of medical care. Consequently only by using the hospital facilities to their maximum capacity can the capital investment be most fully justified.

"IV. Capital investment in hospitals would be more effectively utilized if integrated with the total medical activities—preventive, diagnostic, and therapeutic—of the community.

"V. Fixed charges (interest and depreciation on invested capital) should be regarded as costs correlative with lay and professional services and with consumable supplies. They involve recurrent, though irregular, expenditures which must be met if hospital service is to be continued.

"VI. Hospital financing should attempt 'equitable' distribution of capital costs among beneficiaries (patients, medical professions, general public).

"VII. The allocation of fixed charges against the various hospital functions—bed care, medical diagnosis and treatment, medical and nursing education, and medical and social research—would provide the basis for more effective financing of the various services.

"VIII. Hospital fees should be established with more regard to the total costs of services rendered, including fixed charges, even though it is not intended to recover these costs in full from all patients.

"IX. Knowledge of the total costs—by hospital authorities and by the public—is a prerequisite to the assessment of these costs against different groups of contributors or patients, or the removal of any or all of the burden. Certain groups of patients might consider hospital bills more reasonable if the element of interest and depreciation were properly appreciated.

"X. Fixed charges, even though borne by the general public, must be included in the records and reports of hospitals, if the costs and economies in one institution are to be comparable with those of another. It is unfair to the hospitals to omit these expenditures from the comparisons, and it is unwise for a community to regard 'operating costs' as the total costs of hospital service."

THIRD INTERNATIONAL CONGRESS OF RADIOLOGY

Paris, July 26-31, 1931

The following questions will be discussed at the Third International Congress of Radiology:

(a) Radiological examination of the mucosa of the digestive tube;

(b) Radiological examination of the urinary apparatus by excretion of opaque substances;

(c) Pre- and post-operative treatment

of cancer of the breast by radiation (recurrences and metastases excepted);

(d) Radiotherapy of inflammatory diseases;

(e) Diathermic electrotherapy of inflammatory diseases.

At a general meeting, all Sections being present, a thirty-minute lecture will be given on each of these subjects. All in attendance are invited to give the results of their experience on these questions, both by special communication and during the general discussion.

TRAVELING IN FRANCE

Those in attendance upon the Congress will benefit by a reduction of 50 per cent in the fare to and from the Congress over the French railways.

After the Congress, several tours at reduced rates will be organized to different regions of France, including visits to thermal and mineral watering places.

From the offices of the Congress particulars as to the above-mentioned reduced rates and railway fares, hotel rates in Paris, and the tours following the Congress will be sent to all members of the Congress who have paid their subscriptions. Upon application to the offices of the Congress, also, rooms in Paris during the Congress will be secured for members.

The subscription price to be paid by members of the Congress is 300 French francs. For persons belonging to the members' families who desire to participate in the events arranged for them, the subscription price is 50 French francs.

Summaries of communications designed to be read before the Congress must be in the hands of the officers in Paris before April 1, 1931. These summaries are not to exceed 400 words. They must be typewritten, and may be in the English, French, or German language.

The names of the five American delegates may be found in RADIOLOGY, November, 1930, page 599. Any of them will be glad to furnish information upon request.

Subscriptions are to be sent to the offices of the Third International Congress of Radiology, 122 rue la Boëtie, Paris (8), France.

FIFTEENTH ANNUAL CLINICAL SESSION OF THE AMERICAN COLLEGE OF PHYSICIANS

The Fifteenth Annual Clinical Session of the American College of Physicians will convene in Baltimore, Maryland, March 23-27, and in Washington, D. C., March 28, 1931. The organization holds this Session in Baltimore through the cordial invitation of the Johns Hopkins University School of Medicine, the University of Maryland School of Medicine, the Medical and Chirurgical Faculty of the State of Maryland, the Baltimore City Medical Society, and the further co-operative interest manifested by the various Baltimore hospitals and civic societies. Held in important medical centers, these Clinical Sessions constitute, perhaps, the most important post-graduate week in internal medicine each year. Those who attend the meeting will find ample interest in the way of clinical, laboratory, research, and historical work to repay them well for the time spent in making the journey. Dr. Sydney R. Miller, of Baltimore, President of the American College of Physicians, has prepared the program for the General Scientific Sessions, while Dr. Maurice C. Pincoffs, General Chairman, also of Baltimore, has arranged the program of clinics, demonstrations, entertainment, etc.

As an added feature of the Clinical Session this year, an additional day, March 28, will be spent in Washington, D. C., where a special program of clinics and inspection

tours has been arranged under the auspices of the Medical Departments of the U. S. Army, U. S. Navy, U. S. Public Health Service, and Georgetown University. Dr. William Gerry Morgan is acting as Chairman of the Washington Committee, and is being assisted by Admiral Charles E. Riggs, Surgeon-General of the Navy; General Merritte W. Ireland, Surgeon-General of the Army; General Hugh S. Cumming, Surgeon-General of the U. S. Public Health Service; Dr. William A. White, Director of the Government Hospital for the Insane; Dr. John A. Foote, Dean of the Medical Department of Georgetown University; Dr. Ales Hrdlicka, Director of the Department of Zoology of the National Museum; Dr. Roy Adams, Chief of the Medical Service at Mt. Alto Veterans' Hospital; Dr. W. H. Hough, President of the Medical Society of the District of Columbia; Dr. C. B. Conklin, Secretary of the Medical Society of the District of Columbia; Dr. George W. McCoy, Director of the U. S. Hygienic Laboratory, and Colonel Charles R. Reynolds, Commandant of the U. S. Army Field Hospital School of Carlisle Barracks.

The entire program of the Clinical Session is characterized by new subjects, new authors, and wide geographic representation. It is significant that the committees have attempted carefully to avoid repetition of subjects and authors, as has so often been the case in previous years, not only on the program of the American College of Physicians, but on the program of a great many medical organizations. On the general scientific programs there will be forty-five or fifty selected formal papers. Symposia on blood diseases, oxygen therapy, diseases of the liver, recent advances in endocrinology with particular reference to the newer work on suprarenal extracts, myocarditis, and several other subjects have been arranged. At Baltimore's many modern and excellently operated hospitals, clinics, ward-walks, laboratory demonstrations and the like will be held. Johns Hopkins Hospital and Medical School, under Dr. Alan M. Chesney, Dean, and a specially appointed committee, will place at the disposal of the College all of its facilities and offer a program of great interest. Additional hospitals, such as the Union Memorial Hospital, St. Agnes Hospital, at which Dr. Joseph C. Bloodgood does so much of his work, the Municipal Hospitals, and several of the more private institutions, such as the Howard A. Kelly Hospital, noted particularly for its radium activities, and the Sheppard and Enoch Pratt Hospital, which is one of the most modern dealing with psychiatric problems, and many others will provide programs of clinics.

Hotel headquarters will be at the Lord Baltimore Hotel, while general headquarters, at which the registration of members, commercial exhibits, and all general sessions will be held, will be the Alcazar, Cathedral and Madison streets, Baltimore. Transportation on the Certificate Plan of reduced fares will be available to all physicians and dependent members of their families from all parts of the United States and Canada. A special program of entertainment has been arranged for visiting ladies. The Convocation for the induction of new members as Masters or Fellows, will be held on Wednesday evening, March 25, and the Annual Banquet will be held on Thursday evening, March 26. The business meeting, at which reports of administration and elections for the new year will take place, will be held during the forenoon of Thursday, March 26.

Mr. E. R. Loveland, 133-135 S. 36th Street, Philadelphia, is the Executive Secretary of the College, and it is to him that requests for further information or programs should be addressed.

POST-GRADUATE COURSE

The Eighth Annual Post-graduate Course offered by the Otorhinolaryngological De-

partment of the University of Bordeaux, France, commences July 27, 1931. A five-weeks intensive course in English will be given for American physicians under the personal guidance of Prof. Georges Portmann. The number is limited to twelve physicians, who will act as assistants to Prof. Portmann during this interesting operative course. The subjects to be studied are plastic, sinus, transmaxillary, mastoid, neck, and goiter surgery; bronchoscopy; laryngoscopy; esophagoscopy, and surgery of the tongue.

Particulars may be learned by writing to Leon Felderman, M.D., 413 Mitten Building, Philadelphia, Penna.

DR. PRESTON M. HICKEY: 1865-1930

WHEREAS, the death of Dr. Preston M. Hickey occurred on October 30, 1930, and

WHEREAS, Dr. Preston M. Hickey was the founder of this Society, its most eminent member, and its chief support and inspiration since its organization, and

WHEREAS, he brought renown to himself and this Society by the excellence and multitude of his scientific productions and by his unsurpassed ability as a teacher and practitioner of our profession, and

WHEREAS, his unending enthusiasm and interest in his life work was a constant example for our membership, and his incessant care and utmost patience and sympathy with the afflicted, a pattern for our conduct, and

WHEREAS, he was at all times to some or all of us teacher, associate, companion, and friend, enriching our lives in every contact, be it, therefore,

RESOLVED that his death be recorded in the minutes of this Society with a sentiment of high regard for his memory and a deep sense of loss to all members of this Society, and be it further

RESOLVED that a copy of this memorial be published in the *American Journal of Roentgenology and Radium Therapy* and RADIOLOGY, and a copy be sent to his family, with the sympathy of the Society.

THE DETROIT ROENTGEN RAY AND RADIUM SOCIETY

December 18, 1930

IN MEMORIAM

WEBSTER W. BELDEN, M.D.

The news of the sudden and untimely death of Dr. Webster W. Belden, came as a great shock to his many friends and associates. The circumstances of his illness and its fatal outcome were particularly sad, as Dr. Belden was on a trip combining pleasure and professional interests. After attending the Annual Meeting of the Radiological Society of North America, he was en route to his native town, New Orleans, to visit relatives and to attend a reunion of his boyhood friends, when he was taken ill with pneumonia, resulting in his death a week later at the Touro Infirmary in New Orleans. He was buried at Biloxi, Mississippi, where he had spent much of his boyhood and which he had always wished should be his final resting place.

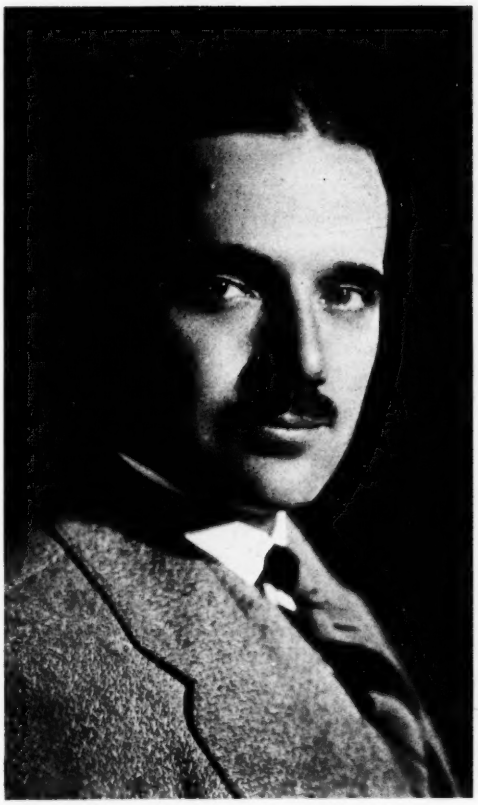
Dr. Belden came of a family of physicians, both his father and grandfather having been members of the medical profession. He was born October 23, 1892, in New Orleans, where he received his early education and later attended Tulane University, receiving the degree of B.S. in 1913 and his medical degree in 1916. Dr. Belden subsequently came to New York City, where he did post-graduate work at Cornell and served his internship at Roosevelt Hospital. During the World War he enlisted in the Medical Corps and served as Adjutant in the Army Medical School. Later he was commissioned Captain and

was in charge of Base Hospital No. 1 and later No. 41. On his discharge from the Army Dr. Belden became associated with Dr. H. M. Imboden, with whom he remained for three years, leaving Dr. Imboden to establish an office in Montclair, N. J. In 1923 Dr. Belden was appointed Director of the Radiological Department of New York Hospital, which position he held at the time of his death.

Dr. Belden was a member of the American Roentgen Ray Society, the Radiological Society of North America, the American Medical Association, New York State and County medical societies, the New York Roentgen Society, and the Clinical Roentgen Society of New Jersey. He was one of the early members of the New York Roentgen Society and was always among its active workers, being deeply interested in its advancement, and serving the Society in all its offices—as Secretary, Treasurer, Vice-president, and President.

While not a prolific writer, Dr. Belden had contributed considerable to the literature, some of his work being outstanding. Among his contributions were: "Some X-ray Findings in Lobar Pneumonia"; "Roentgenological Consideration of the Mediastinum"; "Bone Diseases"; "Secondary Evidence of Gall-bladder Disease"; "The Fifth Lumbar Vertebra Roentgenologically Considered"; "Interthoracic Tumors and Their Treatment," and "Further Study of Osteitis Deformans and its Therapeutic Treatment."

Despite his comparative youth Dr. Belden ranked high in his specialty and gave promise of a brilliant and useful future. His untimely death leaves a vacancy not easily filled and must be regarded as a distinct loss to the profession. As a diagnostician he was particularly keen, many of his interpretations being worthy of men much older in the field of roentgenology. His aid and advice were often sought and always cheerfully given. Whatever he did was done wholeheartedly, and whether he worked or played, it was always with keen interest and enthusiasm. He played hard, but this meant that he worked the harder to compensate for his pleasure.



WEBSTER W. BELDEN, B.S., M.D.

To be able to call Dr. Belden a friend was a privilege. To know him was to love him, but to be his friend was an honor. In the true sense of the word, Dr. Belden had few "friends," but for these no service was too hard, no sacrifice too great. Those who knew him well will always cherish his memory, for

"Not silent are the hallowed dead,
A richer eloquence survives.
We have from those who've gone ahead
The inspiration of their lives."

RESOLUTIONS

The New York Roentgen Society was shocked to learn of the untimely demise of Webster W. Belden, one of its most active members, who has served it loyally as a member and in the capacity of Secretary, Treasurer, and President; who has made many important contributions to the science of roentgenology, and from whom it felt justified to expect a great deal more in the furtherance of the specialty; who upheld the high standards of his vocation as set forth by his grandfather and father, both of whom were honorable members of the medical profession.

The Society feels his loss very keenly and therefore

Resolves, to spread upon its minutes these sentiments of its love and respect for the departed member, and further

Resolves, to express to his widow, his children, his aunt, and his many devoted friends its most heartfelt sympathy, and further

Resolves, that in token thereof a copy of these Resolutions be forwarded to the *American Journal of Roentgenology and Radium Therapy,* and to RADIOLOGY; another to his widow and children, and another to his aunt.

H. M. IMBODEN, M.D.
L. JACHES, M.D.
J. REMER, M.D.

CLAUDE E. QUINN

Dr. Quinn, whose death occurred on January 2, 1931, had been a member of the Society since 1921, and leaves many friends both among radiologists and Indiana physicians. He was born in Cutler, Indiana, and spent his lifetime in his native State. He was a graduate of the State University and began the practice of medicine in the town of Burlington. During the World War he served as First Lieutenant in the Medical Corps. For the past ten years he had practised in Terre Haute. Dr. Quinn was a member of all his State and local medical societies.

BOOK REVIEW

PROCEEDINGS OF THE NINTH ITALIAN CONGRESS OF MEDICAL RADIOLOGISTS, TORINO, ITALY, MAY 20-22, 1930. Published by Societa Italiana di Radiologia Medica. (Press) Immacolata Concezione, Modena, Italy, 1930. Pages 352.

Section I of this work is devoted to a consideration of the roentgenographic anatomy of the skull and a discussion of the roentgenographic signs associated with tumors of the base of the skull.

The roentgenographic anatomy of the skull is considered by Prof. Umberto Nuvoli, who has correlated in an excellent manner the anatomic and roentgenographic features of the skull. The various accepted roentgenographic positions are discussed and the anatomic structures revealed by each are described and illustrated by many roentgenograms and drawings.

Dr. Arrigo Montanari has written a very comprehensive review of the important literature relating to the roentgenographic signs of tumor at the base of the skull, and his paper represents one of the few monographs in which one may find a summary of all the significant roentgenologic data. The various parts of this section are arranged as follows: (1) general radiologic signs of intracranial tumors; (2) general roentgenographic technic; (3) the anterior cerebral fossa; (4) the middle fossa—*(a)* endosellar tumors, *(b)* extrasellar tumors (suprasellar, parasellar, subsellar, presellar, and retrosellar), and (5) the posterior cerebral

fossa. The entire subject is excellently illustrated and represents a distinct contribution to the roentgenologic literature pertaining to the skull.

It is to be regretted that a bibliography of the literature reviewed is not presented for the benefit of those interested. It is unfortunate also that this discussion is available only to those familiar with the Italian language, for it contains much of interest to all roentgenologists.

Section II, by Dr. G. Bignami, concerns radiotherapy in diseases of the blood. The author considers the effects of roentgen rays on (1) leukemias (myeloid and lymphatic), (2) Vaquez's disease, (3) aplastic myelosis, (4) pernicious anemia, (5) malignant granulomatosis, (6) Gaucher's disease, (7) Mikulicz's disease, (8) chloroma, (9) myeloma, (10) lymphosarcoma and lymphosarcomatosis, (11) systemic infections of the lymphatic glands, (12) primary splenomegaly (Banti's, Gamma's disease, splenomegalic hemorrhagic icterus), and (13) hemorrhagic diatheses.

Emphasis is laid upon the statement that treatment should be individualized and not schematicized and that the patient should always be under rigorous clinical control. Roentgenotherapy is the method of choice for chronic leukemias, granuloma malignum, lymphosarcoma, and polycythemia. It is of no value in acute leukemias and in chloroma. In the other groups expert treatment may give worthwhile results in selected cases.

This paper is well worth reading in the original, as it presents succinctly but in a manner not suitable for abstracting a conservative point of view derived from both an evaluation of the literature and the author's own personal experience.

It seems strange that the radiotherapy of pernicious anemia should be included in this review in the face of the well known value of medical treatment with liver, etc. A slight improvement in this paper would be the inclusion of the complete references instead of merely the names of the authors cited.

The reports by L. Siciliano (pages 315-343) on some comments on the problem of radiotherapy of diseases of the blood, and by A. Ferrata (pages 345-352) on blood diseases and roentgen rays, supplement by detailed discussions certain points brought out in Bignami's paper.

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Polarization Measurements on the Human Skin: A Contribution to Basedow's Disease and its Radiotherapeutic Estimation. H. Regelsberger. Fortschr. a. d. Geb. d. Röntgenstr., June, 1930, XLI, 950.

Physiologists are acquainted with a skin reaction which is closely related to skin metabolism: the variable electrical charge of functioning cells is recognized by a change in the measurable bio-electric currents. A. D. Waller, an English physiologist, first pointed out the relations between the intensity of metabolism and electric energy, showing that with proper methods of irritation of the skin or any other living tissues, "blaze-currents" may be obtained and registered as an expression of latent or mobilized metabolic energy. Two different kinds of electrical phenomena may be registered from the skin: (1) directly conductible, permanent, or rest-currents; (2) so-called polarization currents, which are obtained following charging of the skin from a direct current potential. The latter are more easily tested and recorded and were used in these experiments. These currents are influenced by any change of the permeability of cell membranes for the exchange of ions. Mechanical, thermic, electric influences, and ultra-violet irradiation produce such permeability changes. Registering such currents on a large number of patients continually over many days, one obtains curves which show fluctuations comparable to temperature curves, with physiologic elevations and recessions. These are considered to be related to vegetative transformations during assimilation of food. A permanently low curve is found in all diseases accompanied by vagotonia, especially, for instance, bronchial asthma and the post-encephalitic periods. An elevated level of these curves is observed accompanying all cases of sympathicotonia, especially in true Basedow's disease and Reynaud's disease. It is of interest that in the latter the elevation is found only when testing for these currents on the affected extremities, not on the unaffected, while in the former, any portion of the skin participates. In hyperthyroidism (Basedow) the curves may well be used as indicators for the radiotherapeutic results, and, as a whole are more reliable than basal metabolism readings, and constitute valuable additions thereto.

A brief general discussion of these biologic skin phenomena is added, and attention drawn to many rather puzzling problems in connection with this work. Characteristic curves are reproduced.

HANS A. JARRE, M.D.

GYNECOLOGY AND OBSTETRICS

The Development of Gynecological Roentgen Therapy during the Past Ten Years in the Second University Clinic for Women at Budapest. Felix Gál. Strahlentherapie, 1930, XXXVII, 623.

Cases of uterine bleeding during the climacteric are most suitable for roentgen treatment; the percentage of cures reaches almost 100. Before roentgen sterilization, dilatation and curettage are done in each case. Uterine fibroids are either operated on or treated by roentgen rays. During 1929, ninety-two women had the fibroid removed and fifty-one were irradiated. All cases in the climacteric age or women suffering from heart, kidney, or lung disease, or following a long period of bleeding, and fat individuals go to the roentgenologist.

In women under 40 or cases in which there is a suspicion of a submucous degenerated, or large fibroid, ovarian tumor, tumor of the adnexa, or in which the diagnosis is obscure, surgery is given the preference. Cancer of the uterus is operated on only if the case is not advanced and only if there are no other complications.

The remaining patients are treated by radium and X-rays in combination. In a number of cases of sarcoma of the female genital organs, five-year cures were obtained. The treatment of the remaining gynecological conditions amenable to roentgen irradiation does not deviate from that customary in the majority of clinics.

ERNST A. POHLE, M.D., Ph.D.

The Pelvis and Maternal Mortality. Florence Stoney. British Jour. Radiol., September, 1930, III, 426.

The author's article is well illustrated with photographs and roentgenograms of three types of female pelves: (1) from the Bushmen tribe of South African women, whose pelvic inlets were all found to be round (these individuals all wear scanty clothing and have, therefore, an abundance of ultra-violet radiation); (2) the oval type of pelvis of modern British women (who, during growth, receive a limited amount of ultra-violet), and (3) the flattened pelves of the rickety and tri-radiate beaked pelves of the more pronounced osteomalacia type (in which the women, during growth or later in life, have little or no ultra-violet radiation).

The writer then emphasizes the necessity for abundant Vitamin D for all females during both growth and adult life, as a means of reducing maternal mortality.

J. E. HABBE, M.D.

Peculiar Alterations of Ossifying Nuclei of a Syphilitic Fetus. Luigi De Vecchi. La Radiologia Medica, May, 1930, XVII, 575.

This is a radiologic and histologic study of the metatarsus of a syphilitic fetus. The author advances a hypothesis which could explain certain anomalies of the skeleton found later in the area in which development is completed.

L. MARINELLI.

Diagnosis and Therapy of a Case of Hydrops Tubæ Profluens by Salpingography. O. Polano. Strahlentherapie, 1930, XXXVII, 619.

In a woman, 38 years of age, the fifth pregnancy had to be interrupted because of extreme hyperemesis. Since she was also suffering from severe depression, particularly during menstruation, the uterus was removed and the tubes transplanted into the vaginal wound. After a year she returned, complaining of vaginal discharge, severe pain in the back and lower abdomen, accompanied by fever. Examination revealed a tumor about the size of an apple in the right posterior fornix. Assuming that this was an abscess, a needle was introduced and an opaque exudate could be obtained. For the days next following, a dark, thick discharge from the vagina was noticed. Examination revealed a small fistula in the abdominal end of the vagina. The presence of a fistula between ureter and vagina could be excluded. A cav-

ity into which the fistula led was filled with 5 c.c. of an iodin preparation. The roentgen examination permitted the diagnosis of a hydrops of the right tube following vaginal hysterectomy. The right adnexa were removed, also the appendix, and the patient recovered.

The author concludes that even after removal of the uterus, salpingography can be used for differential diagnosis.

ERNST A. POHLE, M.D., Ph.D.

Roentgenological Manifestations of Syphilis in Infancy and Early Childhood. John E. Heatley. Jour. Oklahoma St. Med. Assn., September, 1930, XXIII, 300.

Congenital syphilis is more likely to show bone changes than acquired syphilis and usually several bones are involved. The most common sign during infancy is epiphysitis, which is present in from 70 to 90 per cent of the cases of congenital syphilis in the first three months of life. Later in life, congenital syphilis shows the same bone changes as acquired forms, the most common manifestation being a periostitis. Syphilis is essentially a bone-producing disease, though there may be areas of destruction as well.

W. W. WATKINS, M.D.

The Scientific and Experimental Foundations of Temporary Roentgen Amenorrhea. Hermann Wintz. Strahlentherapie, 1930, XXXVII, 407.

The author discusses in detail the present status of our knowledge concerning temporary sterilization. The article does not lend itself well to abstraction, but it is recommended for study in the original. In conclusion, it is stated that the technic of temporary sterilization has been developed to the same degree of accuracy as any other medical technic. It has been proven that no injury to the patient results from the performance of temporary roentgen sterilization. There are no changes in metabolism, in the skin, in the psyche, in the glands of internal secretion, in the condition of the genitalia, or in the sexual life. The method is, therefore, a valuable addition to our therapeutic procedures.

ERNST A. POHLE, M.D., Ph.D.

Means for an Exact Dosage in Carrying Out Temporary Roentgen Amenorrhea. Th. C. Neeff. Strahlentherapie, 1930, XXXVII, 567.

The author discusses the problem of dosage in the X-ray treatment of women for the purpose of temporary sterilization. It is essential that the correct dose be applied, determined accurately within a small percentage. This requires the use of a reliable measuring instrument which integrates the dose; the chamber must be placed in the vagina; one large front and one large back field must be used, and the two tubes should run simultaneously. This arrangement prevents errors in dosage due to postural changes of the patient.

ERNST A. POHLE, M.D., Ph.D.

Amniography (Preliminary Report). Thomas O. Menees, J. Duane Miller, and Leland E. Holly. Am. Jour. Roentgenol. and Rad. Ther., October, 1930, XXIV, 363.

"Amniography" is proposed as a name for the artificial increase in density of the amniotic fluid to give contrast to fetal soft parts and placenta. This contrast is obtained by the injection of a 1 to 1 solution of U.S.P. strontium iodide through the anterior abdominal wall, with a small lumbar puncture needle. The actual concentration is about 0.75 gm. per cubic centimeter. In 21 cases injected there have been no injurious or toxic effects to the mother or fetus in normal pregnancies. The rate of absorption of strontium iodide was rapid, the fetal contours being lost at about twenty-four hours. The authors conclude that amniography may be of value in the diagnosis of placenta prævia, and in determining the exact relation of the placenta to the cervical canal. In a small percentage of cases the sex of the fetus could be definitely stated.

J. E. HABBE, M.D.

Uterine Fibroids: Analysis of One Thousand Consecutive Cases. Joseph Cohen. Southern Med. Jour., October, 1930, XXIII, 875.

This is an analysis of one thousand consecutive cases of fibroids treated at the Charity Hospital of New Orleans, dating from July 1, 1929. Of these, 103 patients were white and 897 were colored. Only 13 of these were treated with radium, the results not being stated; 695 patients were operated upon, with a mortality of 4.6 per cent. One case had a fibromyosarcoma, and two cases had cervical cancers.

(*Abstractor's note:* This article is thus briefly mentioned to show that the radiation treatment of fibroids has not yet gained the recognition which many radiologists think it should have.)

W. W. WATKINS, M.D.

HEART AND VASCULAR SYSTEM (DIAGNOSIS)

Rupture of the Aorta. C. J. Tidmarsh. Canadian Med. Assn. Jour., September, 1930, XXIII, 416.

This is an interesting case report in which the patient lived for twelve days following a rupture of the descending aorta, 3 cm. in length, and died two days after the onset of right-sided hemiplegia, the result of thrombotic infarct in the brain.

L. J. CARTER, M.D.

Four Cases of Aneurysm. H. E. MacDermot. Canadian Med. Assn. Jour., August, 1930, XXIII, 248.

Detailed reports of the diagnosis and termination of four cases of aneurysm are given. Each case illustrates two cardinal characteristics of aneurysm, namely, the great difficulty attached to its diagnosis and prognosis, and its sudden catastrophic ending. The location of the aneurysm and the cause of death varied. In three of the cases the Wassermann reaction was characteristically positive, while in the other case it was doubtful. The difficulties of diagnosis in each case were marked.

L. J. CARTER, M.D.

The Uncoiled Aorta: Part II.—The Pathologic Aorta. David S. Dann. Am. Jour. Roentgenol. and Rad. Ther., August, 1930, XXIV, 154.

Four types of heart and aortic disease are discussed, *viz.*, arteriosclerotic, syphilitic, hypertensive, and rheumatic. The character of the uncoiled aorta in these conditions is described and illustrated. In the arteriosclerotic type of aorta, the author shows teleoroentgenograms which present a distinct elongation and tortuosity. There is a marked convexity at the base of the supracardiac shadow to the right, just above the right auricle. A similar convexity is noted in the descending aorta to the left of the supracardiac shadow. In the syphilitic aorta a tremendous elongation and tortuosity is shown, with an enlarged heart, horizontal in position. It is in the syphilitic aorta that one can demonstrate the greatest dilatation and uncoiling, measured by the author by taking the transverse and vertical measurements of the entire arch in the left anterior oblique projection. In hypertensive heart disease, the author notes a superiority of the left antero-oblique position over the frontal view, which clearly demonstrates alterations in the aortic tube. While one expects to find the aorta definitely uncoiled in high blood pressure, the author has encountered several cases of high blood pressure, associated with a parenchymatous nephritis, in which no aortic abnormality could be demonstrated. In rheumatic heart disease, the absence of pathologic uncoiling of the aorta is quite conspicuous.

The author concludes that the aorta may be pathologically uncoiled as a result of senile sclerosis, hypertensive heart disease, and syphilis, but the roentgen appearance of the aorta, *per se*, cannot be used for differential diagnosis. The cardiac configuration may be of some aid. The determination of a pathologic uncoiled aorta is but the posi-

tive demonstration of a volumetric change. The roentgen observations should always be correlated with those clinically determined.

J. E. HABBE, M.D.

The Roentgenologic Diagnosis of Coarctation of the Aorta (Adult Type). Walter W. Fray. Am. Jour. Roentgenol. and Rad. Ther., October, 1930, XXIV, 349.

The author believes that he has ample justification for stating that "the roentgenologist has an excellent opportunity to make this diagnosis, entirely unaided by clinical or laboratory data."

The roentgen findings in coarctation of the aorta (adult type) are sufficiently definite and characteristic to establish the diagnosis by this means alone. The simple roentgen technic consists of roentgenoscopic examination, a postero-anterior film and a left postero-anterior oblique film. The direct roentgen signs of coarctation relate to the defect in the aortic arch in the postero-anterior and left anterior oblique views. The indirect signs, left ventricular hypertrophy and dilatation of the ascending aorta, relate to the obstruction of the blood flow through the aorta and the rib erosion to the collateral circulation which results from such obstruction. The direct sign of the defect in the arch and the indirect sign of rib erosion are of the greatest diagnostic importance. Two cases are reported which illustrate the roentgenologic features necessary for establishing the diagnosis.

J. E. HABBE, M.D.

Comparison of the Methods Used for Estimating the Size of the Heart. Sinclair Luton. Southern Med. Jour., August, 1930, XXIII, 681.

In diagnosing chronic heart disease the most important single determination is the size of the heart. This can be done in three ways, namely, by locating the apex beat, percussion, and the X-ray. The X-ray is employed extensively to depict the heart by means of the fluoroscope, orthodiascope, ordinary and two-meter films, the latter giving almost a true picture of the heart's size, if the technic is proper. There are several possibilities of error in the X-ray technic, so that in clinical work an allowance of from 1 to 2 cm. should be made. Physical methods should always be used whether or not X-rays are employed, and there are certain cases in which physical methods alone can determine the size of the heart. This group includes the patients with small left-sided pleural effusions. By perfecting one's self in percussion technic, the heart can be outlined very accurately.

W. W. WATKINS, M.D.

The Excitatory Process Observed in the Exposed Human Heart. Paul S. Barker, A. Garrard Macleod, and John Alexander. Am. Heart Jour., August, 1930, V, 720.

The authors have made classical physiological observations concerning the transmission of impulses within the conducting system of a living human heart in a young man upon whom a pericardiostomy was performed for suppurative pericarditis complicating a streptococcus pneumonia.

Various points on the surface of both ventricles were electrically stimulated with an ingenious electrode introduced through the surgical opening. Simultaneous electrocardiograms recorded the resulting spread of impulse. Existing theories as to the point of origin of extra-systoles in right or left ventricle, and of the anatomical site of lesions involving a single branch of the His-bundle based upon electrocardiographic evidence, are completely reversed in the conclusions drawn from these well planned and carefully executed experiments.

FRED JENNER HODGES, M.D.

The Roentgenologic Appearance of a Thrombosis of the Left Auricular Appendage. Julian Arendt. Röntgenpraxis, Sept. 15, 1930, II, 838.

The roentgenologic demonstration of thrombi in the heart is very rare; only a few such cases have been described. A case is re-

ported by the author of a patient in whom the left auricular appendage was filled by thrombotic masses. The roentgenologic examination demonstrated a peculiar change in the outline of the left heart; especially in that the region of the left auricle was very prominent and appeared denser than the rest of the heart. Dilatation of the left auricle was diagnosed roentgenologically, but an autopsy proved the deformity to be caused by a large thrombus in the left auricular appendage.

H. W. HEFKE, M.D.

HODGKIN'S DISEASE (THERAPY)

A Case of Lymphogranulomatosis Clinically Cured for Four Years. Menna ten Doornkaat-Koolman. Strahlentherapie, 1930, XXXVIII, 147.

The history of a boy, eleven years of age, who was treated for Hodgkin's disease, beginning in 1924, is related in detail. At that time, the occipital, cervical, and inguinal glands were involved, as well as the mediastinum. Between January, 1924, and May, 1925, four series of X-ray deep therapy treatments were applied, combined with prolonged stays in the mountains. Since 1926, the patient has been clinically cured, has physically developed well, and is capable of working as a clerk at the present time.

ERNST A. POHLE, M.D., Ph.D.

Results of Treatment by Autogenous Gland Filtrate in Hodgkin's Disease. Edward M. Hanrahan, Jr. Ann. Surg., July, 1930, XCII, 23.

A brief review of the etiologic theories concerning the nature of Hodgkin's disease is presented. The author is concerned especially with the immunological method of Wallhauser and Whitehead. The procedure consists of the use of autogenous, bacteria-free extracts made from the specific lesions of the disease. This extract was given subcutaneously in small, usually increasing doses, and at frequent intervals. Up to May 21, 1929, Wallhauser reported eleven treated cases, in which five improved, five died (from all causes), and in one treatment was discontinued.

The author treated nine cases of Hodgkin's disease. In certain instances, radium and roentgen-ray therapy were used at various times during the course of the disease. He reports that five of the nine cases treated by him have died of the disease. Three of these five had transitory remissions. Two have returned to irradiation treatment, although one seems slightly improved under the filtrate treatment. Two were apparently unaffected by treatment after ten- and six-week periods, respectively.

F. B. MANDEVILLE, M.D.

MASTOID (DIAGNOSIS)

Procedure for Obtaining Symmetric Images of the Mastoids—Oblique, Antero-posterior, Sagittal Incidence. Carlo Crespellani. La Radiologia Medica, May, 1930, XVII, 558.

This is a description of a simple method of radiological analysis of both mastoids projected on films 13×18 cm., with two views. The accessories employed are very simple and easy to make. They consist of: (1) A cap of ordinary fabric marked for the exact determination of the medium sagittal axis of the skull; (2) a goniometric glass with lines at 52 degrees for the orientation of this axis, with respect to the plane of the film; (3) a centering bridge which prevents lateral displacement of the point of rotation of the head. The technic is essentially the combination of the Worms-Bretton and Arcelin-Garllard methods, and is very simple to follow.

L. MARINELLI.

MEASUREMENT OF RADIATION

The Penetrating Radiation in the Atmosphere. M. H. Schulze. Strahlentherapie, 1930, XXXVI, 270.

The penetrating rays found in the atmosphere, their nature, properties, and measurement, are discussed in this article, which concludes with a brief chapter regarding their bi-

ological effects. The paper is well illustrated by photographs and diagrams and should be studied in the original, since it offers valuable information on a very interesting subject.

ERNST A. POHLE, M.D., Ph.D.

Measuring of the Polarization and Radiation Stimuli. (Second Communication.) Ways and Aspects of a Bio-electric Radiation Dosimetry. H. Regelsberger. Strahlentherapie, 1930, XXXVII, 177.

The author determined the polarization of the skin in irradiated and non-irradiated areas. He found a definite difference in the readings if comparing unexposed, lightly exposed, and heavily exposed fields. (The apparatus has been described in *Fortschritte a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 950.) It is assumed that the cell permeability is one of the most important factors in the observed phenomenon. The possibility of using polarization measurements of the skin in radiation dosimetry is discussed.

ERNST A. POHLE, M.D., Ph.D.

OFFSPRING, EFFECT ON

The Animal Experimental Foundations of the Problem of Late Injuries Due to Roentgen Rays. Ludwig Nürnberger. Strahlentherapie, 1930, XXXVII, 432.

The entire recent literature dealing with investigations of the effect of roentgen rays or radium on the offspring is critically reviewed in this article. The author, who has done considerable research of his own in this field, concludes that, up to date, no positive proof has been offered as to a late injury to the offspring following irradiation of the parents. The experiments of Muller on *Drosophila* can not be interpreted in that sense either. From experiments of other investigators, it appears that the effect of irradiating the generative organs of *Drosophila* does not influence the offspring any more than about fourteen days following the exposure.

ERNST A. POHLE, M.D., Ph.D.

The Development of Children Following Temporary Roentgen or Radium Sterilization of the Mother. H. Naujoks. Strahlentherapie, 1930, XXXVII, 572.

The history of six children is related, who were born of mothers after the latter had undergone temporary sterilization by roentgen rays. Although a few abnormalities were observed in these children, no definite proof of radiation injury could be established. Since temporary roentgen sterilization is being carried out only in rare cases, the author urges all clinicians to publish the records of children born of such patients.

ERNST A. POHLE, M.D., Ph.D.

Injuries to the Gonads Not Caused by X-rays but Due to Extraneous Factors. H. Stieve. Strahlentherapie, 1930, XXXVII, 491.

It is pointed out in this paper that there are many indirect factors which may injure the germ cells, for instance, excessive use of alcohol, caffein, or toxins during infections. Nutritional factors, particularly too much fat in the food, have long been known among farmers to be detrimental to fertility. The climate can also play an important rôle in this connection. In cases in which not all germ cells have been destroyed, the newly formed cells are healthy and furnish healthy offspring. The only danger which lies in the injury of the germ cells *via* a systemic disturbance, is a complete sterilization. This chance is greater in the female than in the male. According to the present status of our knowledge, there is no danger of injury to offspring from germ cells coming from previously injured germ glands. Since the anatomical picture of injuries in germinative tissue, due to extraneous causes, is identical with that following roentgen irradiation, it is left to the reader to draw his own deductions.

ERNST A. POHLE, M.D., Ph.D.

PAGET'S DISEASE (DIAGNOSIS)

Contribution to the Question of Atypical Bone Changes in Osteitis Chronica Defor-

mans Paget. G. Bastian. Röntgenpraxis, June 15, 1930, II, 569.

The typical case of Paget's disease shows a characteristic roentgen picture; there are, however, instances in which a definite diagnosis is difficult or impossible. Recently there has been an attempt to separate osteodystrophia fibrosa into several groups: morbus Paget, Recklinghausen, leontiasis ossea, hyperostosis diffusa. Osteitis deformans Paget and osteitis fibrosa Recklinghausen must to-day be considered as separate diseases. The roentgenologic differential diagnosis is gone into, and an atypical case of Paget's disease is described.

H. W. Hefke, M.D.

Discussion of Some Cases of Osteitis Deformans (Paget's Disease). Ettore Conte. La Radiologia Medica, August, 1930, XVII, 940.

The author has followed, for several years, some cases of Paget's disease. He was able to observe alterations of the base of the skull, and the effect of irradiated ergosterol in a patient having a fracture. Some peculiarities were also noted during the development of the disease in syphilitic patients, and a clear picture is given of the errors in which the radiologist may concur when dealing with fractures of the bones affected by Paget's disease.

L. Marinelli.

PROTECTION

Thicknesses of Lead Protection in the German Ordinances Regarding Protection against Radiant Energy. J. H. van der Tuuk and W. Hondius Boldingh. Fortschr. a. d. Geb. d. Röntgenstr., June, 1930, XLI, 965.

Concerning the Question of Protective Lead Thicknesses in the International Recommendations and the German Ordinances Regarding Protection against Radiant Energy. R. Glocker. Fortschr. a. d. Geb. d. Röntgenstr., June, 1930, XLI, 967.

These two technical papers present some discrepancies in the international and German rules for protection against radiant energy. Glocker evidently arrives at reasonable, compromising conclusions, and gives a corrected curve from which the lead thicknesses necessary for protection with variable potentials may easily be read. This curve, however, should be used only in connection with the complete recommendations and not under any arbitrary conditions.

H. A. Jarre, M.D.

RADIUM

Biological Investigations Concerning the Effect of Graded Doses of Radium on the Skin. A. Reisner. Strahlentherapie, 1930, XXXVIII, 19.

The skin changes following exposure to radium were studied in a number of patients. It appeared that the application of doses considered as toleration doses in the literature produced severe reactions, sometimes a radiodermatitis of the third degree. Tests proved that the over-dosage amounted to about 40 per cent. The doses were reduced accordingly and another series of skin exposures carried out showing that the reaction now corresponded to that of the erythema dose used in roentgen therapy. For the radium applicators used in the tests (14 platinum needles of 0.2 mm. wall thickness containing 3.3 mg. each, placed in a 1.2 mm. brass screen of 2 cm. length, total of 46.2 mg.), the skin tolerance dose amounted to 60 mg.-hrs. if placed directly on the skin and to about 310 to 330 mg.-hrs. if applied in one centimeter's distance from the skin.

The radium erythema was compared with the roentgen erythema. The principal differences were: the radium erythema was darker red and present over two months and longer; the maximum of the reaction appeared later, the pigmentation was more pronounced, and the depth effect greater. A comparison of the

effect of roentgen rays and radium rays can lead to reliable results only if based on identical skin reaction.

ERNST A. POHLE, M.D., Ph.D.

Efficacy of Radium Therapy in Advanced Cases of Cutaneous Carcinomata. Felice Perussia. La Radiologia Medica, April, 1930, XVII, 397.

The author reports five cases of cutaneous carcinoma which were already unsuccessfully treated by surgery and radiation therapy. Favorable results obtained after a rational radium treatment convince him that the theory of radioresistance of tumor is not to be fully relied upon, and that an adequate radium technic yields surprising results even in cases of recurrent and advanced carcinoma of the skin.

L. MARINELLI.

Bacterial Flora in Uterine Carcinomata Treated with Radium. A. M. Bonanno. La Radiologia Medica, July, 1930, XVII, 809.

A study of the bacteria present in 20 cases of uterine carcinoma reveals a heterogeneous flora, in which the staphylococcus and the *saccharomyces hominis* are predominant. Radium therapy seems to reduce the number and the virulence of the micro-organisms. The author shows that some germs disappear after treatment, while the hemolytic and proteolytic effects of others are augmented. It is believed that infected tumors react less favorably to radiation, and that local vaccinal treatment aimed to improve the bacterial flora should be resorted to in advanced cases of uterine carcinoma.

L. MARINELLI.

Biological Effects of Radium Irradiation. R. G. Canti. Acta Radiologica, 1929, Vol. X, Fasc. 4, No. 56, p. 320.

In presenting a short review of the earlier observations on the histology of tumors which were irradiated with gamma rays of radium, the author calls attention to the difficulties in the accurate interpretation of these observations, which were made in most cases on the patient. To overcome these difficulties, Strangeways and his co-workers, especially the author, studied the effect of radiation upon tissue cultures. The influence of time and of the intensity of the applied radiation upon the cell division rate was carefully observed. It was found that a certain threshold dose must be applied before any biological effect of the radiation can be observed. The selective action of gamma rays of radium upon cancer cells can be very well illustrated by the observation of cuttings from the famous "Canti film," a moving picture demonstrating the influence of radiation upon normal cells and Jensen's rat sarcoma cells. The selective action of beta rays on various bacteria is also demonstrated. The "stimulation effect" is discussed and an experiment made on tissue cultures is described, in which an increase in the cell division might erroneously be considered the result of stimulation.

OTTO GLASSER, Ph.D.

Experimental Investigation of the Action of Radium on Certain Micro-organisms. Giuseppe Galli and Arrigo Foà. Rivista di Radiologia e Fisica Medica, August, 1930, II, 412.

The authors investigated the effect of radon on three common bacteria, namely, staphylococcus, streptococcus communis, and bacterium coli. The radon was in glass capillaries varying from 1 to 20 millicuries. Beta and gamma radiation from them both in liquid and solid cultures of these bacteria had little effect, and only when very high doses were used was there a slight retardation of growth. When the capillaries were broken in the culture and so liberated alpha, beta, and gamma radiation, they had a marked immediate bactericidal effect, and a less immediate effect on cultures more than twenty-four hours old. This effect is most marked in liquid cultures and transplants, and is directly proportional to the dose used and inversely

proportional to the volume of the culture and the number of bacteria. With solid media, the alpha rays have a limited bactericidal effect. The authors suspect that solid media are an almost insurmountable barrier to the diffusion of radon.

E. T. LEDDY, M.D.

Radium Application Limited to the Fundus Uteri. Georg Kaboth. Strahlentherapie, 1930, XXXVII, 354.

Uterine bleeding can often be relieved by intra-uterine radium application limited to the fundus, which causes atrophy of the mucous membrane. The author attempted to choose the dose so that the bleeding would be regulated without causing sterilization. If from 1,000 to 1,500 mg.-hrs. were applied to a normal sized uterus, amenorrhea resulted. The same holds true of a slightly enlarged uterus in women near the climacteric. In cases with considerably enlarged uterus, this dose produced, however, the desired effect. It is deduced, therefore, that in women with a normal sized uterus at the ages between twenty and thirty, not more than from 400 to 800 mg.-hrs. should be given. This dose will affect the intra-uterine membrane but will not cause sterilization.

The technic of the procedure is described and accompanied by a sketch of the applicators used.

ERNST A. POHLE, M.D., Ph.D.

Radium in the Treatment of Menorrhagia and Irregular Uterine Hemorrhage. Malcolm Donaldson. British Med. Jour., Nov. 15, 1930, No. 3645, p. 813.

Only after exploration is it justifiable to say that the condition is due to an endocrine disturbance, such as is found at the time of the menopause. Having decided that the patient is suffering from an endocrine disturbance which is not benefited by drugs, the question of treatment will depend, first, on the age of the patient. If she is over 40, then there is no doubt but that the right treatment is to create an artificial menopause by means of radiotherapy. The objection, of course, is the onset of menopausal symptoms, namely, flushing, sweating, headaches, etc.

There are two radiological methods by which the artificial menopause may be brought about: (*a*) radium, (*b*) X-rays.

The technic for using radium in the case of a patient who is over 40 is very simple. The patient is given an anesthetic, and after a careful bimanual examination the uterus is dilated and carefully curetted. If nothing abnormal is discovered, then a tube containing 50 mg. of radium element, the length of which is not more than 2 inches, is placed inside the cavity of the uterus. The walls of this tube must be the equivalent of at least 0.5 mm. of platinum, and in addition it is better to screen the metal filter with 2 mm. of rubber so as to cut off secondary rays. The length of time this tube should be left in position is still a matter of controversy. The majority of gynecologists consider twenty-four hours sufficient, but in a large uterus, with the ovaries near the pelvic wall, this sometimes fails to produce a permanent amenorrhea.

In X-ray treatment, a filter of 5 mm. of aluminum is used, 140 to 150 kilovolts (interrupted current), and a moderately full erythema dose is given to the skin. Two anterior ports of entry are used, and the applicator, applied with compression, is sloped, so that both ovaries get some of the rays. One or two posterior fields are employed, according to the stoutness of the patient—generally one. One of these fields is radiated on each of three or four successive days. This series of fields must be repeated on two further occasions, and it is most important that the beginning of the second series should be four weeks after the first, and the beginning of the third series four weeks after the second. This dose is slightly reduced for these subsequent treatments to compensate for the decreased tolerance of the skin. The method results in very little discomfort to most patients, and they can usually continue their ordinary avocations even during the treatment.

Another method, which is used for patients who live far away, is to sterilize in one treatment. This is a far more severe procedure

for most patients. A filter of 0.5 mm. of copper or zinc is used, 180 kilovolts continuous current, and two, three, or four fields at a 30 cm. distance. Less than an erythema dose is needed.

One advantage over radium is that X-rays can be satisfactorily used with quite large fibroids.

It has been clearly shown from results that: (1) the younger patients will stand a much larger dose without producing amenorrhea, and (2) this method of treatment must seriously be considered in certain cases, even if the patient is under 40, before resorting to hysterectomy.

The disadvantage is the fact that, owing to the position of the ovary being unknown, it is impossible to be certain of getting a dose that will be efficient and yet not produce permanent amenorrhea. The risk in young women of a permanent amenorrhea and severe menopausal symptoms perhaps makes subtotal hysterectomy preferable in the majority of cases.

WALLACE D. MACKENZIE, M.D.

RICKETS (DIAGNOSIS)

The Roentgen Diagnosis of Rickets. Ralph S. Bromer. Am. Jour. Roentgenol. and Rad. Ther., May, 1930, XXIII, 469.

The limitations in the X-ray diagnosis of mild, early, or even more advanced cases of rickets must be recognized, since a certain number of cases will show a Harrison's groove, mild rosary, and lateral mobility of the knee joints, with entirely negative X-ray findings.

Two types, the passive and active, each of which show three stages, according to the degree of healing, are described by the author. The passive type shows no cupping of the diaphyseal ends at any stage, but does show early in the diaphyses of long bones: (1) diminution of lime content, (2) disappearance of zone of temporary calcification, with fine thin shadows running from the disappearing zone of temporary calcification into the resting cartilage of the epiphysis, while the epiphyses show increased width and density of the proliferating and resting cartilage, moth-eaten outlines of the epiphyseal centers, the limiting border at times being absent with the entire nucleus appearing as only a faint haze. The early stage, active type, shows the changes seen in the passive type, but, in addition, the cupping at the diaphyseal ends is also present.

The second stage, passive type, shows: reappearance of the zone of temporary calcification, which at first is faint but which later becomes wider and denser. Between this and the site of the old zone of temporary calcification is a layer of homogeneous bone of lesser calcium content representing the osteoid layer. The return to normal of the epiphyses is represented by, at first, a zone of temporary calcification encircling an osteoid layer of bone. Gradually the moth-eaten, hazy appearance of the epiphyseal centers is replaced by bone of normal structure.

In the second stage, active type, the osteoid layer appears as in the passive form, and, in addition, coarse striations appear in the spongiosa on the shaft-side of the osteoid layer, and at times small cystic areas are also noted. The epiphyseal centers, in addition to showing the changes of the passive type, seem to broaden to meet the widened diaphyseal ends.

In the third stage, both types show a dense, eburnated appearance of the cortex of the long bones, the zones of temporary calcification also being thick, broad and dense. Transverse striations across the diaphyseal ends are often found, although these are, of course, not pathognomonic of healed rickets, but merely represent any disease which at some time has arrested bone growth.

The writer has seen fragmentation of the lower inner border of the diaphysis of the femur and of its lower epiphysis, and of the upper epiphyseal center and upper and lower borders of the tibial diaphysis, with sufficient frequency in this series to suggest that it is an end-result of the rachitic process.

J. E. HABBE, M.D.

Osteomalacia and Fetal Rickets. J. Preston Maxwell. British Jour. Radiol., August, 1930, III, No. 32, p. 375.

The author believes true osteomalacia to be a manifestation of rickets in adults whose bones have reached a stage of maturity, the disease then being due to deficiency of Vitamin D, with actual calcium starvation. Clinically, the patient is apt to complain of pain in the back and thighs, and, if advanced, may show marked deformity of the bones of the chest or pelvis, or of the long bones, there often being bending and crumpling of the weight-bearing bones, with a tendency toward pathologic fracture. In the well marked case, the generalized transparency of all of the bones, which also show a trabeculated appearance, together with certain rather characteristic deformities, make for a reasonably certain diagnosis, although hyperparathyroidism and pseudo-osteomalacia malignum may give the same general picture.

In the severer cases of osteomalacia in childbearing women, the X-ray may demonstrate well marked rickets already present in the newborn.

Illustrations of cases of this nature before and subsequent to appropriate anti-rachitic therapy, are included with the article.

J. E. Habbe, M.D.

ROENTGENOTHERAPY

Spinal Roentgen-ray Therapy in Dermatitis Herpetiformis. Harry R. Foerster. Wisconsin Med. Jour., October, 1930, XXIX, 571.

Roentgen-ray therapy of the spine for cutaneous diseases probably had its inception in the treatment of herpes zoster, and later of lichen planus. The first investigators radiated the sensory nerve roots of the cord, giving rise to the term "radicular therapy." The technic of Driver is the one advocated for the condition described. Two fields are exposed; one interscapular, at the level of the second dorsal vertebra, and the other dorso-lumbar, at the level of the second lumbar vertebra. The rays are perpendicular to the spinous processes, 112 K.V., 5 ma., 25 cm. distance, 3 mm. Al filter, and 7¼ min. time. This is five-eighths of an erythema dose, repeated if necessary in six weeks. Two cases are reported in which the results were good.

W. W. Watkins, M.D.

On the Biologic Effect of Roentgen Rays. Fourth Communication: The Increase of the Roentgen-ray Effect by Secondary Radiation. Ph. Ellinger and E. Gruhn. Strahlentherapie, 1930, XXXVIII, 58.

The effect of substances producing secondary radiation was studied on photographic emulsion and cultures of bacterium prodigiosum. Elements of the atomic numbers from 13 to 92 were used. The effect of the secondary radiation on the photographic plate increased with decreasing wave length of the primary radiation, and with increasing atomic number of the radiating substance. The relation is not linear but there are peaks in the curve. By using aluminum oil as a filter, it becomes probable that the secondary rays are identical with the fluorescent rays of the various series. In order to injure cultures of bacterium prodigiosum by primary roentgen rays, they must be given in doses exceeding 500 r. Between 1,000 and 3,000 r the bacteria are killed. A small percentage survives doses even over 5,000 r. If elements of high atomic number are used for the production of secondary radiation, doses of 300 r of the primary radiation suffice for a complete sterilization of the culture. Primary radiation is most effective if produced at about 100 K.V. The injurious effect of the secondary radiation increases with increasing wave length of the primary radiation, assuming equal doses of primary rays. The bactericidal effect of primary rays is somewhat dependent upon the intensity; lower intensities have a greater effect, assuming equal doses. This factor does not enter if secondary radiation is being used. The bactericidal effect of secondary radiation increases with increasing atomic number of the radiating element; there are characteristic maxima and minima depending upon the wave length of the primary radiation. The bactericidal rays have a very low penetration. An air

layer of from 4 to 5 mm. absorbs them completely. The penetration of the secondary bactericidal rays increases with decreasing wave length of the primary rays. The bactericidal effect is still present even if the radiating element is used in a dilution as low as 1 per cent.

The author concludes that the bactericidal effect of roentgen rays is mostly due to photo-electrons of first and second order.

ERNST A. POHLE, M.D., Ph.D.

The Treatment of Boils and Carbuncles by Roentgen Rays. Eugene T. Leddy and S. Archibald Morton. Minnesota Med., August, 1930, XIII, 554.

Although the roentgen rays have been used successfully for more than twenty years in the treatment of boils and carbuncles, the value of the method is not appreciated by most physicians. The histories of 100 cases have been reviewed, comprising 74 cases of boils and 26 cases of carbuncles. For maximal value the X-ray treatment must be given early, and is considered successful if the lesion disappears in two days or less, and unsuccessful if the process is not materially shortened, even though pain may be relieved. Of the 74 cases of boils, there were only four failures, and of the 26 cases of carbuncles, there were six failures. For boils the technic was as follows: 135 K.V., 4 mm. aluminum filter, 16-inch distance, 5 ma., 10 minutes. For carbuncles the same factors were used for from 15 to 18 minutes. Care must be taken that the field is wide enough to include all the diseased area. If treated when induration alone is present, there should be 80 per cent of cures, without suppuration and without scarring.

W. W. WATKINS, M.D.

A Comparison of the Biological Effect of Roentgen Rays and Gamma Rays of Radium. R. Braun. Strahlentherapie, 1930, XXXVIII, 11.

A comparison of the skin toleration dose of gamma rays of radium expressed in r-units, as measured by a number of investigators, shows a considerable discrepancy in the results. Since the ionization method offers serious difficulties, the author used a biologic test in an attempt to solve the problem. The radium preparations had a length of 15 mm., were filtered through 1 mm. platinum, and were applied at 1 cm. distance from the center to the biologic object. The effect of graded doses of filtered roentgen rays (2,375 r to 6,500 r, half value layer in copper 1.76 mm.) on the eggs of *Ascaris* was compared with graded doses of radium. Based on the identical amount of injury to the *Ascaris* eggs, it appeared that 1 mg.-hr. at 1 cm. distance corresponded to 4.06 r. Tests carried out on that basis with human skin showed that 185 mg.-hr. at 1 cm. distance produced a definite erythema corresponding to that produced by 750 r of filtered roentgen rays. This value is much lower than the majority of previous investigators have offered. The variance is partly explained by the influence of the time factor. Much higher total doses are tolerated by the skin without excessive reaction if given by the fractional method over a long period.

ERNST A. POHLE, M.D., Ph.D.

The Blood Sugar Regulation under the Influence of Roentgen Rays. A. Held. Strahlentherapie, 1930, XXXVIII, 27.

The fluctuations of the blood sugar following exposure to roentgen rays were studied in rats and dogs. The author concludes that one must differentiate between the systemic effect of the blood sugar regulation and the direct effect of the sugar transformation in the irradiated area itself. The general effect of the irradiation manifesting itself in a hyperglycemia is due to cell decay products found in the blood following the exposure. This was proved by re-injection of irradiated blood, which also produced hyperglycemia. The principal factors are apparently an increased hydrogen ion concentration, the transmineralization, and the splitting of proteins. The direct effect of the irradiation on the blood sugar was studied by determining the sugar in the blood of an exposed and an unexposed posterior extremity. In the irradiated tissue there

was a relative hypoglycemia. It is shown that the muscle cell itself may take an active part in the sugar regulation.

ERNST A. POHLE, M.D., Ph.D.

Irradiation of the Sympathetic Ganglia: A Valuable Therapeutic Procedure. K. H. Beall and S. Jagoda. Texas St. Jour. Med., August, 1930, XXVI, 279.

The authors have demonstrated that they can cause a more or less permanent increase in the blood supply to an extremity by radiating the proper sympathetic ganglia. This report is limited to its use in cases in which the arms and legs were affected, though the authors are working to effect an increase in the blood supply to the heart, kidney, and other viscera. Seven cases of thrombo-angiitis obliterans (Buerger's disease) have been treated, in six of which the symptoms were completely relieved. Two cases of Raynaud's disease were treated, with complete relief in two. Three cases of painful claudication from arteriosclerosis were relieved. Some encouraging work has been done in arthritis. The technic was as follows: Weekly treatments at 200 K.V., 4 ma., 25-inch distance, ¾ mm. copper and 1 mm. aluminum for from 10 to 15 minutes.

W. W. WATKINS, M.D.

Experience with the Combination Isamin Blue Radiation Treatment. H. Cramer. Strahlentherapie, 1930, XXXVIII, 123.

The author combined isamin blue injections with radiation therapy in far advanced cases of malignant tumors. The technic of Roosen-Bernhardt was used: 0.4 gram isamin blue was dissolved in 50 c.c. of a 0.5 per cent sterile glucose solution; this must not be heated above 80 degrees or kept longer than 48 hours; 2 c.c. of glycerin are taken up in a syringe, then 10 c.c. of the isamin blue solution, and then a few drops of physiological sodium chloride solution. This is well mixed; three-fourths c.c. of a physiological sodium chloride solution is injected first, followed by a slow injection of the mixture. A series usually consists of from ten to twelve injections; two of 5 c.c. each, two of 10 c.c. each, and from six to eight of 15 c.c. each. In this way, the patient receives a total of from 1 to 1.2 gram of isamin blue. This scheme sometimes must be adapted to the individual needs. The beneficial effect of the combined treatment is demonstrated in a case of bronchial carcinoma which is very difficult to influence.

In conclusion, the author emphasizes that the isamin blue injections should be considered only as an adjunct to radiation therapy.

ERNST A. POHLE, M.D., Ph.D.

The Specific Radiosensitiveness of Lymphocytes: Its Significance in Radiotherapy. Arthur U. Desjardins. California and Western Med., November, 1930, XXXIII, 775.

The author states as follows: "The specific radiosensitiveness of different varieties of cells has been so thoroughly tested and proved by innumerable experiments on animals that it deserves to be recognized as a law. . . . I should like to submit the case of the lymphocyte, which, of all the cells in the body, is by far the most sensitive to irradiation. The fact itself is well known, but its therapeutic implications are not commonly realized. Nowhere in the field of radiotherapy can a more instructive example of the specific sensitiveness of cells be found."

The author reviews Heineke's work of irradiation experiments with animals, with particular reference to the lymphocytic reaction. The lymphocytes are destroyed and the nuclear chromatin is then taken up by the remaining intact cells. The phagocytic disposal of the degenerate nuclear chromatin continues until the lymphocytes in the follicles are largely destroyed, but a small percentage of these cells appears to resist the action of the rays. He also reviews the work of many authors, which confirms the work of Heineke. How may these facts be applied to clinical radiotherapy, and how closely does clinical radiotherapy correspond to the experimental data? It has long been known that many acute and chronic, suppurative or non-suppurative, inflammatory conditions are easily amenable to irradiation, and in some of these conditions roentgen-ray or radium treatment

has been found to be the therapeutic method of choice. As examples, he mentions furuncle, carbuncle, delayed resolution in pneumonia, trachoma, erysipelas, and parotitis. He then discusses the various reactions seen in irradiation of various pathologic conditions.

The mode of action of irradiation is not due to the direct action on infecting organisms, because all experiments testing the bactericidal influence of irradiation have almost constantly been negative. The experiments on animals have shown that the leukocytes and lymphocytic tissue in the irradiated territory may be caused to disintegrate. The chief points to bear in mind are that the destructive action of the rays begins soon after exposure, although visible effects may not become perceptible for several days, and that a considerable degree of lymphocytic disintegration occurs even after a small dose of irradiation.

When an inflammatory lesion is irradiated, destruction of the infiltrating lymphocytes is to be expected. But, since leukocytic infiltration is such an important factor in the defense against infection, the question naturally arises as to why the destruction of a large number of the lymphocytes infiltrating such lesions may not do more harm than good. The only answer is that no one has yet submitted any evidence of such ill-effect. Always the influence of irradiation has been favorable or the rays have failed to alter the course of the inflammatory process. When the author first attempted to ascertain the therapeutic value of irradiation for lesions of this character, this question was uppermost in his mind, and he carefully analyzed all the known experimental and clinical facts.

In the words of the author: "How may such an apparent paradox be explained? After trying to correlate the experimental and clinical observations, I have formulated the following hypothesis which appears to harmonize with all the known facts. If it can be assumed that the leukocytes, and especially the lymphocytes, which the organism mobilizes around the site of infection represent an effort to localize the infection and to get rid of the infectious material by phagocytosis or otherwise, it must also be assumed that the infiltrating cells contain or elaborate within themselves the protective substances or other means which enable them to destroy or neutralize the bacterial or other toxic products which give rise to the defensive inflammation. If these assumptions are well founded, it seems not unreasonable to deduce that irradiation, by destroying the infiltrating lymphocytes, causes the protective substances contained by such cells to be liberated and to be made even more readily available for defensive purposes than they were in the intact cells. There can be little question that the rays act by destroying the infiltrating leukocytes, and that the value of radiotherapy depends chiefly on such action."

The therapy of tumors of the lymphoid tissue is also discussed.

F. B. Sheldon, M.D.

The Sensitizing Effect of Hematoporphyrins to Roentgen Rays. N. A. Podkaminsky. Strahlentherapie, 1930, XXXVIII, 98.

Hematoporphyrin was injected into white mice which were exposed to roentgen rays in the dark. The same sub-acute and chronic types of the disease which usually develops after light exposure of sensitized animals were observed in these mice. It is concluded, therefore, that hematoporphyrin is a sensitizing agent for roentgen rays as well as for light rays.

Ernst A. Pohle, M.D., Ph.D.

Principles of the "Long Weak" Treatment Method. G. Schwarz. Strahlentherapie, 1930, XXXVII, 709.

The author explains a treatment method which permits the use of roentgen rays similar to radium. Very low tube currents (0.5 ma.) are employed for prolonged periods. In order to facilitate the practical work, special transportable X-ray apparatus is being constructed according to the author's design which can be moved to the sickroom and connected to the ordinary light circuit. The chief advantage of the method lies in the production of very mild skin reaction even though very high total

doses may be applied (2.5 r per minute, 1,800 r during 36 hours) with several hours' interval between the treatments.

ERNST A. POHLE, M.D., Ph.D.

Roentgenotherapy of Bronchial Asthma. G. M. Sack. Röntgenpraxis, Oct. 1, 1930, II, 890.

Before roentgenotherapy for asthma is instituted the diagnosis must be certain. In this way one avoids giving unnecessary treatment for tuberculosis or heart and blood-vessel diseases. The number of eosinophiles in the blood picture does not give any indication for the prognosis, as far as irradiation is concerned. Old cases also react well to roentgen treatment. Secondary changes, however, caused by the long existence of asthma, cannot be influenced. Irradiation of the lung hili through four small fields (6×8 cm.), with 0.5 Zn filter and 1/10 to 1/5 of a skin erythema dose, gives good and lasting results and is less troublesome to the patient than larger doses.

Of 45 patients treated by the author, 25 were cured, 6 considerably improved, 4 did not react, and 10 could not be followed up. Children especially reacted very well. Patients treated in an early stage may be benefited sooner and easier than old cases. The action of the rays may be explained by changes in the tonus of the sympathetic and parasympathetic system. These changes are probably of biochemical nature. Other allergic diseases react to irradiation as does asthma.

H. W. HEFKE, M.D.

Xanthomatosis (Schüller's Disease; Christian's Syndrome): A Report of Three Cases Treated with Roentgen Rays. Merrill C. Sosman. Am. Jour. Roentgenol. and Rad. Ther., June, 1930, XXIII, 581.

Three cases of probable xanthomatosis are reported, two occurring in children aged two and a half and four and a half, and the third in a man aged fifty-five. All three showed general improvement under X-ray treatment, and corresponding improvement in the defects in the membranous bones. The characteristic roentgen findings are irregularly rounded areas of destruction in the skull and pelvis, with occasional lesions in other bones. Diabetes insipidus and exophthalmos are frequently associated findings, and these indicate the presence of xanthoma tumors in the region of pituitary body and orbit. While the etiology of the disease is unknown, a definitely disordered fat metabolism is constantly present, which accounts for the previously reported good results with low fat diets, although two of the three cases reported herein showed no response with such dietetic regulation. The important finding of the author is the consistently good response in each case to irradiation therapy.

J. E. HABBE, M.D.

Value of Roentgenotherapy in Carcinomatous Metastasis of Bone. Arduino Ratti. Rivista di Radiologia e Fisica Medica, August, 1930, II, 389.

This is a report of a patient with extensive metastasis to the bones of the pelvis following carcinoma of the breast, who was clinically well a year after treatment.

E. T. LEDDY, M.D.

Further Experience with the Roentgen Treatment of Brain Tumor. Karlheinz Backmund. Strahlentherapie, 1930, XXXVII, 59.

Since the last report from the author's clinic (*Strahlentherapie*, 1928, XXIX, 678) of forty-two cases of brain tumor, thirty-two additional patients were seen in 1927-28. Twenty-five of these cases could be used for the statistics. Eight patients were clinically cured, three were permanently improved, four temporarily improved, nine not improved, while one died immediately after the first irradiation. In spite of this fatality, the author can not agree with the statement made in the literature that in each case of brain tumor, a decompression should be carried out before starting X-ray deep therapy. He urges that X-ray therapy be given a trial in each case of

brain tumor, and, if this treatment fails, all well localized tumors should be removed by surgery.

ERNST A. POHLE, M.D., Ph.D.

Radiation Therapy in Menstrual Headaches. Charles L. Martin. Texas St. Jour. Med., August, 1930, XXVI, 280.

One type of menstrual headache appears to be due to some improper relationship between the secretions of the pituitary and the ovary. It is usually absent during pregnancy and relieved by the menopause. An artificial menopause produced during the latter years of the menstrual life brings about a cure or marked relief in many such cases. The artificial menopause should never be induced in young women except under unusual circumstances. Mild glandular radiation when properly understood, and when not carried too far, may prove of value.

W. W. WATKINS, M.D.

Present Methods and Results of Radiation Therapy in Carcinoma with Fractional Doses. Leopold Freund. Strahlentherapie, 1930, XXXVII, 795.

The author acknowledges the fact that the fractional dose method in the treatment of carcinoma is more and more practised to-day and with very good results. Since he recommended this method twenty-five years ago, he claims priority for the idea of increasing the effect of radiation on tumor tissue by subdividing the dose.

ERNST A. POHLE, M.D., Ph.D.

Testicular Seminomas and Their Treatment by Means of Roentgen Rays. J. B. Porchovnik and G. N. Treister. Röntgenpraxis, Oct. 15, 1930, II, 927.

The seminomas are the most common tumors of the testis. Sixteen such cases have been treated by the authors during the last four years. As metastases often take place soon after surgical removal, it seems advisable to treat the field of operation and the surrounding lymph glands soon afterwards. The seminoma itself, as well as its metastases, is very sensitive to roentgen rays. One should begin the treatment with one-fourth skin erythema dose per field, and should give larger doses later only in refractory tumors. Roentgen therapy is the only method of treatment in neglected cases and metastatic tumors of different organs. One may even succeed in achieving a complete cure in some cases, and often in improving the condition of the patient considerably for many months and even years.

H. W. HEFKE, M.D.

Auxiliary Methods in Radiation Therapy of Carcinoma. Henri Hirsch. Strahlentherapie, 1930, XXXVII, 767.

A number of measures have been described which serve as adjuncts to radiation therapy in malignant disease. The author discusses briefly the copper iontophoresis of the uterus as practised by Wintz, the gas treatment by Fischer-Wasels, the dye injection of Roosen, and the bismuth injections of Kahn and Wirth. The lead therapy of Blair Bell is also mentioned. Hirsch himself has seen favorable results from the injections of Dextrozid, which is an iodine-cer compound coupled to hypertonic dextro solution. Diathermy and organ extracts may also prove valuable in combination with radiation therapy.

ERNST A. POHLE, M.D., Ph.D.

Plantar Warts. Cyril K. Valade. Jour. Michigan St. Med. Soc., July, 1930, XXIX, 521.

The treatment of plantar warts numbers three methods: plasters or pastes containing keratolytic drugs, surgical diathermy, and radiation. X-ray therapy is perfectly safe in the hands of a competent radiologist. The procedure is simple. The surrounding skin is screened to the edge of the lesion, then unfiltered radiation is applied for the required dosage. MacKee advises one and one-half skin units; this will depend on the amount of cal-

losity present, so that two or more skin units may be required. If the wart has not disappeared in four weeks, it is safe to give another dose.

W. W. WATKINS, M.D.

A Case of Endometriosis Rectovaginalis Treated Successfully by Roentgen Rays. James Heyman. Strahlentherapie, 1930, XXXVII, 590.

The history of a woman thirty-one years of age suffering from an extensive endometrioma is related by the author. Since operation did not bring relief, she was referred for radiation treatment. She responded well to roentgen therapy, and, following a period of amenorrhea, menstruation returned. Heyman suggests, therefore, the revision of the textbook opinion which assumes that roentgen therapy is not indicated in the treatment of endometrioma.

ERNST A. POHLE, M.D., Ph.D.

The Effect of X-rays on the Reticulo-endothelial System of the Spleen. Ettore Conte. Rivista di Radiologia e Fisica Medica, August, 1930, II, 430.

The author reports experiments on the action of X-rays in producing the so-called "block" of the reticulo-endothelial system of the spleen. He found a paralyzing effect on the activity of the cells to take up colored substances and suspensions of granules of India ink. This effect began a few hours after irradiation, and was of short duration.

E. T. LEDDY, M.D.

The Roentgen Therapy of Subacute and Chronic Pelvic Inflammatory Diseases. L. Seitz. Strahlentherapie, 1930, XXXVII, 595.

The author has observed in his clinic, 380 cases of pelvic inflammatory disease, 366 of which were treated by roentgen rays. About 78 per cent were improved, subjectively as well as objectively. Technic: 180 K.V., 1.0 mm. Cu + 1.0 mm. Al, one abdominal field 20 cm. × 20 cm., 15 per cent to 20 per cent E.D. on the surface or 4 per cent to 6 per cent E.D. in the depth. In addition to that, hot douches, diathermy, and other conservative methods of treatment were used.

An analysis of these cases leads to the following conclusions: In acute cases of gonorrheal etiology, roentgen rays should not as a rule be used; no contra-indications exist for the acute types of parametritis. The principal domains for roentgen therapy in small doses are the subacute and chronic diseases of the adnexa, and also parametritis. Even in cases of gonorrheal infection of the tubes, roentgen therapy is beneficial in 75 per cent of the cases, and certainly must be recommended as a valuable adjunct of other therapeutic measures. The inflammatory processes in the peritoneum are favorably influenced in almost 100 per cent of the cases. In order to judge the therapeutic effect, it is suggested that one observe the leukocyte count and also the blood sedimentation. Particularly in septic types of pelvic inflammatory disease, these tests give valuable information as to the efficacy of the therapeutic measures.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Treatment of Lymphogranulomatosis. H. U. Billich. Strahlentherapie, 1930, XXXVIII, 141.

The author observed thirty-one cases of Hodgkin's disease, 38.7 per cent of the patients being women, most of them young or of middle age—twenty-three were between the ages of ten and forty. A table gives the localization, stage of the disease, the time of observation, and the results of the treatment. It appears that 25.5 per cent lived two years and longer; 29 per cent lived three years, and two patients lived over three and five years, respectively. One woman has been under treatment since 1920, had a recurrence in 1927, and is still alive. The author emphasizes that roentgen therapy should be administered in medium doses. As a matter of fact, a study of the literature shows a definite tendency towards a reduction of the amount of irradiation prescribed in Hodgkin's disease. Particularly the soft glands require only small

doses. From 50 to 200 r (170 K.V. to 180 K.V., 0.5 Zn + 1.0 Al) are usually given in the author's clinic. High doses lead to a rapid destruction of the pathological tissue, the absorption of which by the blood stream causes violent systemic reactions. The application of the lowest possible dose necessary to bring about relief is, therefore, the method of choice. In addition to irradiation, the general treatment of the patient must not be neglected.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Agranulocytosis. F. Burgheim. Strahlentherapie, 1930, XXXVIII, 152.

The application of very small doses of highly filtered roentgen rays (30 r per field, 175 K.V., 0.6 mm. Cu) over as many bone-marrow areas as possible in the beginning of the disease, is recommended by the author. In his experience, this treatment helped in restoring the regenerative function of the bone marrow.

ERNST A. POHLE, M.D., Ph.D.

Further Experience with Roentgen Therapy in Tuberculosis of the Adnexa. H. Eymer. Strahlentherapie, 1930, XXXVII, 603.

The author reports briefly the results obtained by roentgen therapy in fourteen women suffering from tuberculosis of the adnexa. The patients were between fifteen and forty-four years old; only one had had one miscarriage and seven had carried a pregnancy to full term. They received very small doses of roentgen rays two to six times, at intervals of from a few days to a few weeks. One large field over the abdomen was given. Twelve of the fourteen patients were considerably improved, one remained unchanged, and one died from intestinal tuberculosis.

Although we do not know the mechanism of the effect of roentgen rays on tuberculous tissue, it seems apparent that small doses of roentgen rays are of benefit in these cases. Before attempting X-ray therapy, active tuberculous processes in lungs, intestines, or genito-urinary tract must be excluded.

ERNST A. POHLE, M.D., Ph.D.

Unusual Deposition of Calcium in Connective Tissue. Max Cohn and Freye. Med. Klinik, Sept. 19, 1930, XXVI, No. 38, p. 1400.

An unusual case of generalized calcinosis is described, and several roentgen films are shown revealing the extent of the disease. The motility of the extremities was very limited on account of the extensive deposits of calcium around the shoulder. A trial of roentgenotherapy (1/5 of the erythema dose every second day until a full erythema dose was given) led to encouraging results. After the first week the patient complained less and had better use of his arms. It may be that the X-rays cause an increased amount of acid in the tissues, which again may lead to a dissolution of the calcium salts.

H. W. HEFKE, M.D.

Uterine Sarcoma and Roentgen Therapy. Antoine Béclère. Strahlentherapie, 1930, XXXVIII, 113.

Radiation therapy can be used to advantage following the surgical removal of a sarcomatous uterus. It is indicated as the method of treatment in all inoperable cases, in all cases in which operation can not be performed, in all cases of recurrence, and for metastasis. The article has been published in French in *Gynéc. et Obstétr.*, January, 1930.

ERNST A. POHLE, M.D., Ph.D.

Actinomycosis (Mycetoma): Report of Six Cases in Georgia. Jack W. Jones and Herbert S. Alden. Southern Med. Jour., October, 1930, XXIII, 906.

By the term "actinomycosis" the authors mean a slowly progressive, chronic, infectious granuloma, caused by various fungi of different genera and species, presenting clinically nodular hypertrophies of the infected tissue, and frequently draining sinuses. The terms "actinomycosis" and "mycetoma," as used by Castellani, are synonymous. The manner in which the fungus enters the system is not definitely known. After gaining entrance to the tissues, the fungus grows slowly, but persist-

ently, extending mycelial filaments into the surrounding tissue. The connective tissue response is marked and much new tissue is formed far from the invading organism. The disease actinomycosis probably occurs more commonly than is believed. Six cases are reported by the author. The diagnostic fetich of "sulphur granules" is a mistake, and the appearance of such bodies marks a terminal condition. Except in one instance, no granules were ever found in the cases reported. The fungus may be demonstrated in the infected tissue by curetting the sinus. The treatment consists of the persistent use of iodine, arsenic, and by X-radiation. In the cases cited, the radiation applied was unfiltered and from one-fourth to one-half skin-unit dose a week.

(*Abstractor's note:* It would appear that the radiation used was inadequate, and that more intensive radiation, with moderately high voltage and moderate filtration, would have given better results.)

W. W. Watkins, M.D.

On Radiation Therapy of Pleuritis Carcinomatosa and Sarcomatosa Exudativa. I. Heeren. Strahlentherapie, 1930, XXXVII, 735.

The histories of seven patients observed in Holfelder's Clinic, suffering from pleura metastases, are briefly related. In five cases, the primary tumor was in the breast, in one case in the uterus, and in another case there was a round-cell sarcoma in the head of the left humerus. While X-ray deep therapy of the metastatic malignancies in the chest did not lead to a cure, there was considerable improvement in the condition of the patients. A number of roentgenograms accompany the article, illustrating the effect of irradiation.

Ernst A. Pohle, M.D., Ph.D.

A Contribution to the Roentgen Treatment of Para-urethral Infiltrates. Sepp Grauer. Wien. klin. Wchnschr., Aug. 14, 1930, XLIII, No. 33, p. 1032.

The good results of roentgenotherapy in complications of gonorrhea are well known, especially in gonorrheal arthritis. Also an epididymitis, prostatitis, and vesiculitis can be favorably influenced by roentgen irradiation. Several cases of gonorrheal para-urethral infiltrates were treated by the author, with excellent results. The factors of dosage used were: 4 H, wave length lambda effective = 0.1 Å.U., filtration 0.3 mm. Cu and 2 mm. Al. This dose was given three times at weekly intervals. The testicles were well protected by lead. Every case of this kind should be treated by roentgen rays before surgery is resorted to, and in most cases, the author believes, irradiation treatment will be so successful that surgery will not need to be employed.

H. W. Hefke, M.D.

Radiation Treatment in Myelogenous Leukemia. Sigfrid Hammerschlag and Heinz Knospe. Strahlentherapie, 1930, XXXVII, 693.

There is related briefly the history of a woman who was suffering from myelogenous leukemia, with an enormously enlarged spleen which had previously been diagnosed as an ovarian tumor. She responded well to X-ray treatment (deep therapy technic) in small and moderate doses. The authors emphasize the statement that most radiologists believe in using this procedure rather than giving massive doses. One-third to one-half E.D. over the spleen or over the long bones is suggested.

Ernst A. Pohle, M.D., Ph.D.

Principles of Roentgenotherapy: VIII.—Roentgen Therapy in Gynecology. Ernst A. Pohle. Wisconsin Med. Jour., August, 1930, XXIX, 442.

Paper No. 8 of this series discusses the use of roentgen therapy in uterine fibroids, in cases in which roentgen sterilization is desired, in amenorrhea, and in malignant conditions. For suitable cases of fibroids, X-ray therapy (or radium) is given preference by the majority of clinicians, and if strict indications are observed, the results approximate 100 per cent. When fibroids are large or pressure symptoms distressing, if the growth is sub-

mucous, subserous, or pedunculated, if the hemoglobin is below 40, if there are inflammatory processes in the adnexa, if the fibroid is necrotic, if the patient is in the child-bearing period, or if there is a suspicion of an ovarian cyst, surgery is usually preferred. Treatment is directed toward cessation of the ovarian function, and usually 35 per cent of the so-called erythema dose, or 250 r of heavily filtered radiation, is sufficient. A variety of technics are employed. The treatment of excessive menstruation in women close to the menopause is essentially the same. The matter of "temporary sterilization" in younger women is discussed and caution advised. The treatment of amenorrhea by small doses of X-ray has been advocated by some authorities. In malignancy of the uterus both radium and X-rays are used, since the radiation by radium alone cannot reach the pelvic glands. Roentgen rays of short wave length and in toleration doses are required. A thorough knowledge of the fundamentals of radiation therapy and continued study of reactions are the basis of good results. The possession of radium and an X-ray machine does not qualify any one to treat such cases.

W. W. WATKINS, M.D.

Principles of Roentgenotherapy. IX.—Roentgen Therapy in Dermatology. Ernst A. Pohle. Wisconsin Med. Jour., September, 1930, XXIX, 507.

The first therapeutic use of X-rays was in skin diseases. The successful X-ray treatment of such lesions requires a careful study of the individual patient and continued observation after exposure. The author uses the outline of MacKee, and indicates the dosage and technic for treatment of the following conditions: diseases due to pyogenic organisms, diseases due to fungi, eczema, psoriasis, lichen planus, pruritus, diseases of the appendages, diseases of the hematopoietic system, tuberculous lesions, verrucous lesions, non-malignant neoplasms, and malignant neoplasms.

(Abstractor's note:—This article, like MacKee's writings, is very conservative, and many radiologists would add a number of skin diseases to this list.)

W. W. WATKINS, M.D.

Principles of Roentgenotherapy. X.—Roentgen Therapy in Pediatrics, Ophthalmology, Otology, Rhinology, Laryngology, Neurology, and Psychiatry. Ernst A. Pohle. Wisconsin Med. Jour., October, 1930, XXIX, 565.

In pediatrics a number of conditions are amenable to radiation therapy; many peculiarities connected with a growing organism demand special consideration in establishing indications and contra-indications, as well as in establishing technic. In enlarged thymus, the majority of radiologists use X-rays, some preferring radium. Small doses of X-rays are used, 30 r to 75 r, with potentials from 100 to 130 K.V., 4 mm. Al or 0.25 mm. copper. Tuberculous glands may be successfully treated, the single dose of moderate penetration of from 50 r to 150 r, repeated two or three times at intervals of from three to ten days. From four to six weeks should elapse between such series. In acute leukemia, radiation is not used. In chronic leukemia, the same method of application as in adults is used; the same is true in Hodgkin's disease. In the treatment of inflammatory conditions, the principal point is the use of small doses, 30 r to 75 r, the penetration being of minor importance.

In the eye the number of conditions amenable to radiation is limited, although considerable literature has accumulated on the radiation treatment of malignancies in and around the eye. In the ear, radiation is usually used in inflammatory conditions. Sinusitis, with severe pain, is often relieved by X-ray. Hypertrophied tonsils sometimes reduce under X-ray treatment, fairly high doses of filtered rays being advised. Perhaps the treatment is more applicable to the hypertrophied lymphoid tissue of the pharynx. In brain tumors, radiation therapy should be given a trial, and it is safe to apply 200 r per field for four days, or until the tumor itself has received about 600 r.

Tumors of the hypophysis may be given 200 r to 300 r of heavily filtered radiation through each of three portals, repeated after two to

four weeks. Cases of syringomyelia, poliomyelitis, encephalitis, multiple sclerosis, and tabes have also been radiated.

W. W. WATKINS, M.D.

Nitrogen Excretion in the Urine Following Roentgen and Radium Treatment. Günter K. F. Schultze. Strahlentherapie, 1930, XXXVII, 642.

Forty-two patients were placed on a certain diet until the nitrogen excretion became constant. Twenty-two were treated by roentgen rays over the pelvis, eight received radium, and the twelve remaining patients were treated for non-malignant conditions and served as controls. It appeared that following radium treatment, the nitrogen in the urine was increased in all cases. This increase is more constant and higher than following roentgen treatment. While other investigators found that the creatinin nitrogen was also increased, the author could not confirm their observations. The conclusion is reached that the determination of the nitrogen in the urine following irradiation cannot be used as a factor in prognosis or biologic dosimetry. Further studies are necessary in order to give a broader basis for this problem.

ERNST A. POHLE, M.D., Ph.D.

SKIN (THERAPY)

Ringworm of the Hands and Feet. Wilmoth A. Osborne. Med. Sentinel, August, 1930, XXXVIII, 426.

Ringworm of the hands and feet may be caused by any one of several kinds of fungi. The clinical appearance and symptomatology show great variability, with some definite and constant features. Usually the primary lesion is a deep-seated vesicle along the sides of fingers or toes; the lesions may be discrete or may coalesce. The changes may run the gamut from acute erythema, through vesicular and pustular, into scaly and indurative forms.

In the discussion of treatment this author says: "The roentgen ray has been lauded by a number of observers. In some of the acute eczematoid cases it gives improvement, but again it is only one of the many measures which may be tried. There is little rational therapeutic basis for its use in any other form than the acute eczematoid type."

(Abstractor's note:—Radiologists who have had experience in treating eczematoid ringworm will hardly agree with this brief dismissal of the use of the X-ray in the condition. It is true that the X-ray is usually tried "when all else fails"; it is also just as true that it usually relieves the condition when it is tried.)

W. W. WATKINS, M.D.

Studies of the Changes of the Skin Tolerance Using the Fractional Dose Method with Varying Intervals. Alfred Reisner. Strahlentherapie, 1930, XXXVII, 779.

The skin reactions produced by a number of modifications of the saturation method were studied on the skin of the thigh. A 2 cm. × 2 cm. field exposed to 1,000 r in one sitting served as control. The skin reactions were determined with the tintometer designed by Schall. A color plate showing the exposed areas on the fortieth and fiftieth days, respectively, following exposure illustrates the results. The reactions are carefully analyzed in a number of graphs. If a lower initial dose than 1,000 r was given, higher doses had to be applied than indicated by the saturation curve of Pfahler in order to get the same degree of erythema as in the case of a full initial dose. It also appeared that saturation at daily intervals produced less reaction than if carried out at two-day intervals.

ERNST A. POHLE, M.D., Ph.D.

Skin Diseases about the Eyes. Russell Fields. Virginia Med. Monthly, July, 1930, LVII, 248.

Chronic eczema is frequently benefited by mild doses of X-ray. In external angular conjunctivitis, cauterization with silver nitrate, together with small doses of X-ray, will be found useful. In epitheliomas upon and sur-

rounding the eyelids, the judicious use of X-ray and radium, with desiccation when indicated, will cure the average case. The eye is less susceptible to radiation than the surrounding structures.

Other conditions are discussed in which radiation is not advised as treatment.

W. W. WATKINS, M.D.

The Influence of Air Pressure on the Formation of Erythema and Pigmentation in the Skin. F. Schmidt-Labaume and E. Uhlmann. Strahlentherapie, 1930, XXXVIII, 54.

A number of skin areas were exposed on the backs of patients, to a Kromayer lamp. By means of a special arrangement, it was possible to apply the radiation under a positive or negative air pressure of 40 mm. mercury. The increased pressure led to a decrease in the erythema and pigmentation, while the negative pressure increased these reactions. These results are explained by the anemia or hyperemia of the exposed skin.

ERNST A. POHLE, M.D., Ph.D.

Dermatologic Therapeutics: Basic Principles and Technic. Moses Scholtz. California and Western Med., November, 1930, XXXIII, 769.

The author discusses the therapeutics of dermatology, with special reference to the general practitioner. The types of skin found in different individuals and different locations, and some of the principles of diagnosis are discussed. He says that failure to correctly recognize the primary and secondary lesions and interpret their proper relationship is responsible for many therapeutic failures. As a rule, the secondary lesion should be treated first. He spends quite a bit of time in discussing details in the proper application of therapeutic remedies, and also gives attention to diet, general regimen, and internal medication.

The most effective and powerful of all therapeutic resources available to dermatologists is physiotherapy. Ultra-violet light, quartz lamp, or carbon arc possesses dermatologically the following effects: (1) bactericidal; (2) antipruritic; (3) stimulative regenerative; (4) superficially destructive peeling. On the other hand, X-ray and radium in small and medium doses exert a stimulative, alternative, and deep absorptive effect, and large doses are lethal to rapidly growing tissues. Hence ultra-violet light is indicated in all superficial itching, infectious, bacterial or mycotic, local or systemic dermatoses. The X-ray should be used only in deeper, infiltrating, inflammatory dermatoses, infectious granulomas, bacterial or mycotic, and in skin malignancy.

For a clinician who uses the X-ray in skin cases, a thorough grounding in diagnostic and therapeutic dermatologic technic is an important qualification. A principle that should be indelibly impressed upon the mind of a clinician using the X-ray in skin diseases is that the therapeutic skill of a clinician is measured by the smallest dosage used in obtaining desirable therapeutic effect.

Over-treatment, so often observed in the X-ray treatment of skin disease, refers not only to the quantity of ray expressed in amperage, but also to the quality of ray as well, a much higher voltage being commonly used than is necessary for therapeutic effect or compatible with safety to the skin.

Similarly, in the field of the ultra-violet light there is a tendency to use erythema and blistering doses more often than is necessary. Commercial circulars flooding the profession have hypnotized the average practitioner into a belief that nothing short of an erythema or blistering dose is sufficient for therapeutic results. In actuality, most of the major therapeutic effects obtained through ultra-violet light rays, such as antipruritic, bactericidal, and stimulating regenerative, are obtained by small fractional or medium doses, away below the erythema stage. The superficially destructive and peeling effect of the erythema dose is desired only in a very small minority of dermatoses, such as chronic circumscribed dry scaly mycotic dermatoses, acne, psoriasis, alopecia areata, and some other selected cases.

F. B. SHELDON, M.D.

The Possibility of Preventing Radiation Injuries to the Skin. Erich Uhlmann. Strahlentherapie, 1930, XXXVIII, 103.

Raderma cream, which consists of adeps lanæ, vaseline, ceresin, and oily or watery extracts from semen terminaliæ, folia psidi pyriferi, and radix rumicis crispi has been recommended by Wintz as prophylaxis for severe skin reactions following exposure to roentgen rays or radium. The author investigated the value of this ointment, and found that the application of the preparation reduced the effect of the exposure on the skin by approximately 20 per cent. He recommends its use, therefore, particularly in cases in which more than one series of treatments must be given.

ERNST A. POHLE, M.D., Ph.D.

Electrodesiccation *versus* Radiotherapy in the Treatment of the Basal-cell Epithelioma of the Skin. Gustave Archambault and Albéric Marin. Canadian Med. Assn. Jour., June, 1930, XXII, 829.

Fifty-three cases are reported, of which 21 were treated with X-ray and 32 with electrodesiccation. The end-results were practically the same, each type of treatment yielding 91 per cent cures and 9 per cent failures. The X-ray treatment comprised curettage of the lesion under ethyl chloride local anesthesia, followed immediately by one massive X-ray treatment—two or three skin units. The factors for a skin unit employed were 100 K.V., 2 ma., 8 in. skin-to-target distance, no filtration, a Coolidge tube, 3 minutes. For electrodesiccation the monopolar current of Oudin was used. The electrode was held near the lesion, a noiseless spark of fairly strong intensity being used.

L. J. CARTER, M.D.

SKULL (DIAGNOSIS)

Radiographic Researches of Technic of Anatomy and of Semeiotics of the Pars Petrosa. Arduino Ratti. La Radiologia Medica, August, 1930, XVII, 916.

This is a systematic study of the pathological and normal anatomy of the pars petrosa, with the purpose of finding the points on which the radiologist must focus his attention, and with the idea of determining the best technic to follow. The author used a cadaver and practised experimental alteration of the zone. A detailed discussion of the results is given, and as far as the technic is concerned, the author prefers the sagittal antero-posterior projection.

L. MARINELLI.

The Importance of Encephalography for the Diagnosis and Therapy of Infantile Paralysis. Ludwig Guttmann. Med. Klin., June 13, 1930, XXVI, 886.

Encephalography can give the clinician a picture of the anatomical formation in cases of infantile paralysis, if its limitations are remembered. A more exact diagnosis, *intra vitam*, can thereby be achieved. The author distinguishes four groups into which he classifies cases according to the roentgen findings: (1) Hemiatrophia cerebri, with porus formation; (2) atrophia cerebri, without porus formation; (3) primary malformation of the brain; (4) meningopathic processes.

The author claims that an encephalogram will in most cases allow of a differential diagnosis between these four groups.

H. W. HEFKE, M.D.

Intracranial Calcification and its Roentgenologic Significance. John D. Camp. Am. Jour. Roentgenol. and Rad. Ther., June, 1930, XXIII, 615.

The author reviews the records of 781 verified brain lesions at the Mayo Clinic, and finds that only 7.6 per cent have produced calcification of sufficient degree to be detected roentgenologically. Physiologic or normal intracranial calcification occurs in the pineal gland oftenest, and less commonly in the choroid plexus, falx cerebri, and pacchionian bodies. Pathological conditions which may give rise to calcification are tumors, hematomas, tubercles, aneurysms, old abscesses, and areas of old meningitis or encephalitis. Neoplastic tumors showing calcification oftenest are gliomas, endotheliomas, suprasellar cysts, heman-

giomas, dermoids, and cholesteatomas. From the character and location of the calcification and the pressure effects upon adjacent bony structures, a roentgenologic differentiation is at times possible.

A number of illustrations of physiologic and pathologic calcifications are included in the article.

J. E. HABBE, M.D.

Trauma and Calcification of the Cerebral Falx. Giorgio Betocchi. Rivista di Radiologia e Fisica Medica, January, 1930, II, 49.

The author has observed calcification of the cerebral falx in two patients who had head injuries. One of these had optic neuritis and both of them had chronic oto-maxillo-ethmoiditis. He assigns a pathogenic part to this inflammation, especially if there is antecedent syphilis, and thinks that the trauma plays an indifferent rôle.

E. T. LEDDY, M.D.

Encephalography in Cases with Fixed Lesions of the Brain. Bronson Crothers, Edward C. Vogt, and R. Cannon Eley. Am. Jour. Dis. Child., August, 1930, XL, 227.

This paper is concerned chiefly with a comparatively large group of neurologic cases found in children, namely, those with cerebral damage. The authors outline their technic in detail, and, although they respect the manometric values set by Pancoast and Fay, they tend to rely more on eyeground changes and cracked pot percussion notes, during the injection of air. A number of films are included from a series of 200 consecutive cases. In 50 per cent of the cases, encephalograms suggested cerebral atrophy. As an admittedly severe and probably dangerous procedure, the authors know of no case in which its use has led to an aggravation of previously existing disorders. One case of death of a child with an advanced glioma is given in detail.

In conclusion, the conventional diagnoses of feeblemindedness, epilepsy, and cerebral palsy do not define the anatomical lesions or the physiologic residue, nor do they suggest logical educational programs. The traditional period of hospital observation, investigation of the blood, spinal fluid, and routine roentgenograms of the skull, have given little information of definite value. Encephalograms, properly taken and intelligently interpreted, give definite information in at least half of properly selected cases, and negative facts of importance can be established in the remainder. Decisions should not be made on the basis of encephalograms alone, but the authors believe in this method before final judgment is passed upon the future of children severely handicapped by fixed cerebral lesions, unless less severe methods are demonstrably adequate.

F. B. MANDEVILLE, M.D.

Angioma Racemosum in the Skull. L. Frigyér. Röntgenpraxis, July 1, 1930, II, 619.

Because only two similar case reports could be found, the author reports the clinical and roentgen findings of a case, that of a male patient who had a large nevus over the left side of the face and symptoms attributable to a left-sided brain lesion. The X-ray film showed a large area of calcified vessels in the skull, which was considered to be a partly calcified intra-cranial angioma.

H. W. HEFKE, M.D.

Studies in Pneumo-encephalography. Frederic J. Farnell, Seth F. H. Howes, and Jessie B. Hudson. Rhode Island Med. Jour., August, 1930, XIII, 115.

Since the simplification of the method of air injection by its introduction *via* the spinal route without the use of an anesthetic, a procedure of great diagnostic value has been placed within the reach of the clinicians and one which carries with it a comparative safety and the greatest simplicity. This report is based on twenty-five patients examined by this method and includes traumatic psychosis (one), senile psychosis (two), dementia præcox (three), epileptic psychosis (five), epidemic encephalitis (three), dementia paralytica (seven), hysteria (one), narcolepsy

(one), mid-brain disease (two), undetermined (one). In the series, dementia præcox, epilepsies, and hysterical psychosis gave little or no changes in ventricular shadows. The epidemic encephalitis, dementia paralytica, and senile disorders presented changes in their ventricular systems and pia-arachnoidal pathways. Further observations of such cases may lead to valuable conclusions.

W. W. WATKINS, M.D.

Intracranial Pressure: The Correlation of Choked Disc and Roentgenologic Pressure Signs. Frederic Schreiber. Am. Jour. Roentgenol. and Rad. Ther., June, 1930, XXIII, 607.

An attempt has been made to correlate the clinical findings of choked disc, indicating increased intracranial pressure, and the roentgenologic demonstration of the same condition. The X-ray appearances in positive cases were graded slight, moderate, and marked, the estimate being based on the number and depth of convolutional impressions, atrophy of bone at the base and about the sella, and separation of sutures.

In no cases in which pressure symptoms were of less than two months' duration were there any X-ray findings of increased intracranial pressure. The rapidly invasive tumors, which were accompanied by the highest percentage of choked disc, showed the lowest percentage of X-ray pressure signs. The slowly invasive group of tumors (astrocytomas) showed the highest percentage (57) of roentgen signs of increased intracranial pressure, but 86 per cent of these also showed choked disc.

J. E. HABBE, M.D.

Traumatic Pneumocephalus: Report of Eight Cases. Carl W. Rand. Arch. Surg., June, 1930, XX, 935.

The term "traumatic pneumocephalus" may be broadly used to designate the entrance of air into the brain or cranial cavity following a fracture of the skull. This occurs particularly in those cases of fractures of the skull which communicate with the paranasal sinuses, especially the frontal sinus. It may occur immediately or within several weeks following the injury. If evidence of air is found, an operative repair of the dural rent should be attempted. The diagnosis is made in practically all cases by means of the roentgen examination, which discloses not only the amount of air present but its location.

Eight cases are reported in this communication and of these three patients died of meningitis. One of these cases had been operated upon after meningitis had become general. In five other operative cases there was complete recovery following closure of the opening in the dura.

HOWARD P. DOUB, M.D.

Indirect Signs of Brain Tumor as Noted in Routine Roentgen Examinations: Displacement of the Pineal Shadow: A Survey of 3,000 Consecutive Skull Examinations. Cornelius G. Dyke. Am. Jour. Roentgenol. and Rad. Ther., June, 1930, XXIII, 598.

A review of 2,724 routine skull roentgenograms and their subsequent case histories was made by the author to determine the significance of the reliability of pineal gland displacement. The gland was visible because of calcium content in 51 per cent of the total number, or 59 per cent of the patients over twenty years of age. Displacement, as determined by the method of Vastine and Kinney, was present in 39 per cent of all verified intracranial tumors, the most frequent displacement being in gliomas, which, in 56 per cent of all cases showed displacement, and meningiomas, 43 per cent of which showed pineal displacement. Fourteen per cent of not definitely proven pathologic cases showed pineal displacement, but a certain percentage of this group, the author believes, probably represents actual tumor pathology which, however, is not yet proven by operation or necropsy. The intracranial tumor apparently always displaces the pineal gland away from the pathologic side if displacement does occur, except in pituitary gland lesions.

J. E. HABBE, M.D.

SKULL (THERAPY)

Treatment of Acute Head Injuries. Antonio D. Young. Jour. Oklahoma St. Med. Assn., June, 1930, XXIII, 184.

The treatment of head injuries causes more anxiety than almost any other emergency of practice. Upon admission to the hospital, if shock is present, this is to be treated first. Immediate surgical treatment is usually necessary only for superficial hemorrhage or scalp laceration; all further surgery can wait until recovery from shock, when a more accurate diagnosis of the case can be made.

When the patient's condition warrants, X-ray examination of the skull should be made, with a sufficient number of films to give details of the nature and site of the fractures, if any be present. Rarely has a patient ever died of a fractured skull; he dies because of hemorrhage, brain destruction, or intracranial pressure. Every minute saved in beginning treatment of a severe case of head injury increases the chances of survival. Too often, valuable time is lost in waiting for unnecessary roentgenograms, while the patient's shock and intracranial pressure go unattended. The patient will survive or succumb independent of fractured skull, so early X-ray films are not necessary. Following recovery from shock, the next essential step is to make the X-ray examinations completely and thoroughly.

W. W. Watkins, M.D.

The Radical Treatment of Traumatic Epilepsy and its Rationale. Wilder Penfield. Canadian Med. Assn. Jour., August, 1930, XXIII, 189.

Localization of the site from which an attack of focal epilepsy arises can rarely be determined by neurological examination alone. In an analysis of convulsive patterns it is necessary to borrow from the observations of physiological experimenters. The author analyzes from this viewpoint the phenomena produced by lesions in various areas, *viz.*, the precentral gyrus, the frontal adversive field, the occipital eye field, the temporal adversive field, and the island of Reil.

The most important diagnostic measure is encephalography, or roentgenography of the brain after spinal air insufflation. By this means it is possible to demonstrate cysts which connect with the ventricle or the subarachnoid space, to determine cortical atrophy, and to discover the size, shape, and position of the ventricles. Localized brain scars are associated with wandering of the ventricles toward the site and side of the lesion.

Four interesting case reports are given in detail, three from the neurological service of the Royal Victoria Hospital, Montreal, and one from the service of the Presbyterian Hospital, New York City. In each case, methods of examination are given in detail and the radical treatment employed is described. In three cases, operation was done under novocain analgesia, and the hemispheres were explored electrically during the operation.

In Case I there had been a depressed fracture of the left frontal bone seven years previously. The lesion being localized as in the left frontal area, the left frontal lobe was excised, with good results. There have been no convulsions in the year that has elapsed since the operation.

In Case II a diagnosis of a contracting scar in the right cerebral hemisphere was made. There was a history of fracture of the parietal bone ten years before, convulsions beginning two years after the accident. At the operation multiple lesions were found in the right motor and temporal areas, and a portion of the scarred area was removed. There has been mental improvement and comparative freedom from attacks in the year following operation.

In Case III there had been a depressed fracture of the right frontal bone three years previously. Epileptiform convulsions began three years after the accident. X-ray examination showed the anterior horns of both lateral ventricles, as well as the third ventricle, to be displaced somewhat to the right. At operation an extra-cerebral cyst was found over the right frontal area, the anterior part of the right frontal lobe was hard-

ened and yellowish in color, with adhesions to the dura and to the adjoining hemisphere of the opposite side. This lobe was amputated. In the thirty months which have elapsed since operation there has been no recurrent attack.

In Case IV there had been a depressed fracture of the right side of the skull, followed in four months by epileptiform seizures. X-ray examination showed moderate enlargement of the right ventricle and a deflection of the whole ventricular system to the right side. At operation the right dura was found to be densely adherent. This was removed with the underlying brain. There was good recovery for six months, when the attacks returned.

L. J. CARTER, M.D.

SPINE (DIAGNOSIS)

Hypertorsion of the Child's Cervical Spine in the Roentgenogram. E. Kehrer. Strahlentherapie, 1930, XXXVII, 609.

It is stated that the cervical spine of children permits an extensive torsion of the head, much more than in an adult. This fact must be considered in diagnosing the intra-uterine position of an embryo as shown on roentgen examination, in order to prevent errors in interpretation. Certain changes in position can be brought about by external forces, as, for instance, changes in position of the delivering woman. A number of cases are briefly reported, accompanied by roentgenograms of the pelvis, illustrating the author's contention.

ERNST A. POHLE, M.D., Ph.D.

A Contribution to the Study of the Significance of Some Particular Alterations of the Vertebræ. Desiderio Perotti. La Radiologia Medica, August, 1930, XVII, 932.

The author describes seven cases in which clinical symptoms led to a diagnosis of spondylitis. The radiological investigation revealed anomalies of the limiting surfaces of the vertebræ, and spherical-shaped depressions which presented some of the cartilaginous nodules described by Schmorl. These lesions are regarded as of tuberculous origin, and must be interpreted as either initial stages of vertebral decay or as isolated areas of the tuberculous process surrounded by calcification of the bone in which they are located. In the opinion of the author the most important signs of early spondylitis are Schmorl's nodules and the enlargement of the inter-vertebral spaces, with irregularities of the limiting surfaces.

L. MARINELLI.

X-ray Observations in Low-back Injuries. James C. Johnston. Jour. Oklahoma St. Med. Assn., April, 1930, XXIII, 114.

Although many back injuries will show no visible changes in the bones, at times evidences which are significant may be found. Particular care should be taken to examine the fifth lumbar vertebra and its articulations for slight changes shortly after injury, and for subsequent bone deposits indicating ligament and joint injury. If the type of trauma applied and the direction of the force are borne in mnid, it will assist in making and interpreting roentgenograms.

W. W. WATKINS, M.D.

The Differential Diagnosis of the Pain of Angina Pectoris and the Radicular Syndrome of Hypertrophic Osteo-arthritis of the Spine. Don C. Sutton. Illinois Med. Jour., September, 1930, LVIII, 202.

In the presence of hypertrophic osteo-arthritis of the spine, angina pectoris should be diagnosed when (1) the attacks follow effort and are of short duration after rest; (2) the individual with an anginal attack, regardless of its mildness, has a fear of continuing effort and stops of his own accord; (3) attacks following a heavy meal disappear after the stomach is emptied; (4) nocturnal attacks are of similar short duration and a history of pain following effort can be obtained; (5) anginal attacks always disappear after the giving of nitrites to full physiological effect.

The referred pain of nerve-root pressure in hypertrophic osteo-arthritis should be diagnosed when (1) pain is increased by move-

ments of the spine and is steady in character; sharp, stabbing, or cutting pains may be felt at the periphery of nerve distribution; (2) the steady pain or ache is often felt most after exercise and is persistent for long periods; (3) carefully elicited history reveals similar pain on the right side and usually over other spinal nerves; (4) Déjerine's sign is present, especially after sneezing or coughing; (5) pain is often felt between the shoulder blades; (6) the X-ray shows evidence of hypertrophic changes in the bodies of the vertebræ. The nerve pain is hypertrophic osteoarthritis of the spine is never relieved by the administration of nitrites.

C. H. DeWitt, M.D.

Myelomatosis in a Child of Eight Years. Paul Jacoby. Acta Radiologica, 1930, XI, Fasc. 2, 224.

A case of myelomatosis of the spine is reported. The vertebræ showed a compressed structure and were markedly decalcified. At postmortem examination, the vertebræ were found to be masses of soft, reddish material, practically without osseous structure.

M. J. Geyman, M.D.

An Analysis of One Hundred Consecutive Cases of Back Strain. Myron O. Henry. Minnesota Med., August, 1930, XIII, 572.

Study was undertaken to determine the relative frequency and importance of the various findings in cases of back strain occurring in private practice. Every case was studied with stereoscopic, antero-posterior, and lateral roentgenograms. Eighty per cent showed some sort of anatomic variation of congenital type. Abnormally placed postero-lateral articulations were found in 63 per cent of the cases. Sacralization appeared in 5 per cent and spina bifida in 7 per cent. Arthritic changes were shown in 5 per cent. This is a most bothersome condition to insurance companies, the expression "pre-existing dormant arthritis, aggravated by injury" having become very common. Most cases can be relieved by rest and mechanical support and fixation, although fusion operations are sometimes required.

W. W. Watkins, M.D.

A New Radiographic Method for the Study of the Cervical Vertebræ. Pietro Ottonello. Anales de Radiologia, April, 1930, II, 57.

The technic, as described by the author in radiographing the cervical vertebræ in the antero-posterior position, is as follows: The patient lies on the Bucky in the supine position, with the head slightly extended and held with a compression band, and the rays are centered on the chin, with the patient's mouth closed. (While the author gives specific radiographic factors, these, of course, can be changed in accordance with the technic used by the operator; the longer the exposure time, the better.) During the exposure the patient opens and closes his mouth rhythmically, while holding his breath, at a rate of once or twice per second.

Illustrations accompanying the article show that the movement of the lower jaw, while somewhat blurring the field covered by the mandible during movement, permits the visualization of all the cervical vertebræ, and the blurring does not seem to interfere with the diagnostic qualities of the film.

P. R. Casellas, M.D.

The Klippel-Feil Disease. A. J. Pytel and S. S. Chaievitch. Vestnik Rentgenologii i Radiologii, 1930, VIII, No. 1, p. 45.

The Klippel-Feil disease is an affection of the cervical vertebræ, characterized by shortening of the neck, limitation of motion of the head, and low limit of the hair on the back of the neck. The head appears to rest directly on the thoracic cavity. Roentgenologic investigation of the neck will often reveal complete fusion of the cervical vertebræ, giving the appearance of a single mass. The number of cervical vertebræ may be diminished. Occasionally a spina bifida may be discovered, and frequently other anomalous affections are found in the skeletal system. The etiological

factors of the disease are not known: most frequently it is of congenital origin.

The authors report four cases, all of them being in female patients. Photographs and roentgenographs accompany the paper.

SAMUEL BROWN, M.D.

The Differential Diagnosis of Diseases and Post-traumatic Changes of the Vertebræ. Hans Holfelder. Röntgenpraxis, Oct. 1, 1930, II, 865.

Diseases and post-traumatic changes of the vertebræ are the most difficult chapters in industrial surgery. It is possible to demonstrate all parts of the vertebræ on the film; an antero-posterior examination alone should not be considered sufficient, but a lateral film should always be taken. Stereoscopic films may be desirable in certain cases and are technically not difficult to obtain. The interpretation of roentgenograms of the vertebræ, especially in relationship to post-traumatic changes, is not simple, as entirely different causes may lead to the same anatomical changes. It is important, for insurance purposes, to have a roentgen examination of the vertebræ in every case of spine injury immediately after the accident. It is then possible to state in the future whether or not pathological changes were present at the time of the injury, or if they were sequences of it. Recent fractures of the vertebral bodies are usually easy to diagnose, but the diagnosis of fractures of the transverse processes are more difficult. A fracture of the transverse processes without dislocation has not been described in the literature, and we should hesitate to diagnose it unless some displacement is present. Occasionally it is impossible to demonstrate recent fractures of the arches. Secondary bone changes such as callus and deformities may lead to a diagnosis some time after the injury. Slight injuries of the vertebral bodies usually lead to later changes, especially arthritic and hypertrophic in character, which may cause considerable discomfort and pain. Such changes, however, may take place not only after injuries but also due to arthritis deformans. Clinical symptoms are often entirely absent even with marked roentgenologic findings. The roentgenologic findings and the clinical symptoms do not always parallel each other. A generalized spondylitis deformans cannot be explained as caused by an injury. A localized spondylarthritis deformans, when found in the neighborhood of the injured area, should be considered as caused by an accident, as long as we do not know more about this disease.

In later stages of post-traumatic changes, many differential diagnostic difficulties present themselves. Congenital synostoses, and congenital deformities of the vertebral bodies may be mistaken for old fractures. However, the height of the body in these cases is normal in congenital abnormalities, and decreased after fractures. Cervical ribs, lumbar ribs, and anomalies in the region of the fifth lumbar and the first sacral vertebræ must sometimes be differentiated from post-traumatic changes. The narrowing of a body may be due to senile osteoporosis, or osteomalacia, or to Perthes' disease isolated in a vertebral body; also tumors and infectious diseases may lead to a narrowing and partial destruction. The differential diagnosis from a post-traumatic narrowing by the roentgen film alone is sometimes impossible. If one finds the contour of the vertebra in question, protruding over the neighboring vertebræ, one should think of a fracture rather than a metastatic or inflammatory process. Each case has its own problems, and we are still far distant from a satisfactory understanding.

H. W. HEFKE, M.D.

THROAT (DIAGNOSIS)

The Roentgen Examination in Diseases of the Trachea. Max Sgalitzer. Röntgenpraxis, July 15, 1930, II, 636.

The X-ray examination is able to show pathological displacement and narrowing of the trachea better than any other clinical method. Such changes are most often caused in goiter patients. The value of the roentgen examination in determining the presence of a substernal goiter is well known. One examination which is not generally known is the test of the resistance of the tracheal wall by Val-

salva's and Müller's method (increase and decrease of the intratracheal air pressure). Tracheomalacia can thus easily be demonstrated. Not only goiters, but glandular tumors of the neck and mediastinum, aneurysms, lung tumors, tuberculosis, pneumothorax, and hydrothorax may lead to a displacement of the trachea. Aneurysms most often seem to displace the trachea laterally, and mediastinal tumors, anteriorly or posteriorly.

H. W. HEFKE, M.D.

THYMUS (DIAGNOSIS)

The Incidence of Widened Thymic Shadows in the New-born. J. Victor Greenebaum, Leo S. Friedman, and Samuel Brown. Jour. Med., February, 1930, X, 577.

Roentgenograms have been made of the thymus glands of all white babies born in the free wards of the Jewish Hospital, during the past five years, and 304 consecutive roentgenograms form the basis of this report. Only films taken when the baby was quiet are included. In the series 30.5 per cent showed widened thymic shadows. They regard a standardized technic as essential, if 3 cm. in the second interspace is taken as the upper limit of normal.

W. W. WATKINS, M.D.

Some Observations on the Thymus in Early Infancy. E. H. Shannon. Canadian Med. Assn. Jour., June, 1930, XXII, 775.

This study is an analysis from the findings contained in the radiography of the thymus glands of 219 infants. The technic employed was as follows: focal skin distance of 30 inches, 30 ma., 80 K.V., one-quarter second. The target must be centered accurately over the thymus at a point one inch below the suprasternal notch. Only normal cases were radiated, and from the series were excluded prematures and all cases presenting symptoms referable to the thymus. Measurements of the thymus shadow were made, at the level of the third thoracic vertebra, of the total transverse diameter of the gland, and of the external diameter of the chest at the same level. The smallest thymus found measured 2.2 cm. and the largest 5.4 cm., the average of all cases being 3.2 centimeters. The average ratio of thymus to chest diameter was 1:22.

In a further series of 50 consecutive cases referred for examination or treatment, with more or less definite symptoms of thymic enlargement, the largest shadow was 4.6 cm. and the smallest 2.4 centimeters. The average size was 3.4 cm., and the average thymus-chest ratio was 1:207.

The conclusions reached from the study of the two series of cases are that the presence of a large thymus shadow on the X-ray plate has no direct or definite interpretation in terms of pathology or clinical symptoms, and that, therefore, clinical manifestations should be the sole index as to the advisability of treatment. While the discrepancy between the size of the gland and production of symptoms favors the endocrine theory of thymus disease, those who uphold the mechanical theory offer the obvious and irrefutable argument that where an apparently small gland appears to produce symptoms, there actually exists anteroposterior enlargement not demonstrable in the roentgenogram. The chief value of roentgenograms of the thymus in early infancy is to confirm an indefinite clinical diagnosis of enlarged thymus, or to check the results of X-ray treatment in reducing the size of the gland shadow. They are also of value in determining changes in the size of the gland in cases which show recurrence of symptoms.

In order to determine what changes take place in the size of the thymus gland in the first few days of life a further series of 33 cases were radiographed. The average size within 5 hours of birth was 3.7 cm., whereas the average three days later was 3.15 centimeters. Very little change was noted in size subsequent to the third or fourth day. The practical conclusion from this latter series was that the examination should be delayed until the third or fourth day after birth, unless there are urgent indications earlier. The

technic employed in X-ray treatment, where indicated, was as follows: focal skin distance 10 inches, 90 K.V., 5 ma., filtration of 4 mm. aluminum. Treatments are given alternately anteriorly and posteriorly over the gland area for four doses at weekly intervals. The only criteria of treatment are that it should reduce the size of the gland without being too heavy.

L. J. CARTER, M.D.

Thymic Shadows of New-born Infants. H. B. Podlasky and S. E. Kohn. Am. Jour. Dis. Child., April, 1930, XXXIX, 782.

One hundred consecutive new-born infants, less than twenty-four hours old, were studied. According to the authors, it was not always possible to obtain roentgenograms in the same phase of respiration. The so-called postero-anterior position in recumbency at full inspiration has been considered best by the authors. A standard technic at 30 inch distance, one-eighth second exposure, 55 K.V., and 25 ma. was used.

A mediastinum one and one-third times the width of the thoracic vertebræ, measured at the second thoracic level, was considered normal. By definitely enlarged, the authors mean a width at the second thoracic vertebra which proved to be more than twice that of the latter's transverse diameter.

With the above standards, 35 of the 100 infants showed definitely enlarged thymuses. None of the symptoms usually referable to thymic enlargement was evident in the 35 cases described.

The authors mention that great variation has been found in the size of the thymus between recumbent and upright positions, and in inspiratory and expiratory phases.

Lateral views were not included in this study, as suggested by Pancoast and Pendergrass, in their recent work.

F. B. MANDEVILLE, M.D.

Hyperplasia of the Thymus: A Study of 1,045 Patients Including Available Family and Maternal History. Sam W. Donaldson. Am. Jour. Roentgenol. and Rad. Ther., November, 1930, XXIV, 523.

The writer emphasizes the importance of an early diagnosis of hyperplasia of the thymus. The diagnosis and treatment of an enlarged thymus is a problem of the radiologist. The author has found satisfactory results in the treatment by using the small fractional dose method, the average case receiving three or four treatments.

He emphasizes the belief that enlargement of the thymus appears to belong to family groups. Roentgen examination is indicated in all children in whom a familial history of enlarged thymus in the children is obtained. Certain cases of thymic enlargement do not decrease in size after irradiation but the symptoms subside. There is only unconvincing evidence that there may be a relation between enlarged thymus in the offspring and thyroid disturbance in the mother. While there is some evidence that larger babies are more apt to have enlargement of the thymus than the smaller ones, this is not enough to limit investigation to the larger babies only. The finding of an enlarged thymus shadow was slightly more common in females in this series of cases.

J. E. HABBE, M.D.

THYROID (DIAGNOSIS)

Hyperparathyroidism. John de J. Pemberton and Kenneth B. Geddie. Ann. Surg., August, 1930, XCII, 202.

A case of hyperparathyroidism in a girl fourteen years of age, due to excessive parathyroid secretion caused by parathyroid adenoma, is presented in detail. Hypercalcemia, hypophosphatemia, progressive weakness, loss of muscular tonus, abdominal pain, vomiting, anemia, polydipsia, polyuria, and decalcification of the skeleton, are the main symptoms.

In the authors' case roentgenograms of all of the bones presented evidence of a diffuse decalcification without loss of the normal structure of bone. Films of the skull vault, pelvis, and knees are included in the paper. Roentgenograms taken four weeks after the

removal of the parathyroid adenoma did not reveal any increase in the density of the bones. The clinical symptoms were improved.

The literature on the parathyroid glands since their discovery by Sandstrom is reviewed by the authors. The possible relationship of hyperparathyroidism to osteomalacia, osteitis fibrosa, rickets, and tetany is discussed.

F. B. MANDEVILLE, M.D.

The Clinical Syndrome of Hyperparathyroidism. David P. Barr and Harold A. Bulger. Am. Jour. Med. Sci., April, 1930, CLXXIX, 449.

Hoffheinz was able to collect 45 cases in which parathyroid tumor or hyperplasia was certain between the years 1900 and 1925. To this number the authors have added 29 more. These include both malignant and benign tumors, as well as enlargement due to simple hyperplasia.

The symptoms of clinical hyperparathyroidism are similar to those produced by the experimental injection of excessive amounts of parathormone, *i. e.*, hypertonia and diminished electrical excitability of muscle, decalcification of bones, hypercalcemia, and abnormal excretion of calcium in the urine. Hypercalcemia is the most significant clinical sign in the diagnosis of hyperparathyoidism and usually indicates increased function of the parathyroid glands.

There is apparently a direct relation between tumors of the parathyroids, with increased function, and generalized osteitis fibrosa cystica (von Recklinghausen's disease), as 32 of these patients suffered from a generalized form of osteitis fibrosa cystica. Nine others were diagnosed as osteomalacia. A number of the cases collected by the authors showed marked improvement, with a definite decrease in the serum calcium after the removal of the parathyroid tumors. The authors feel that in generalized osteitis fibrosa cystica the clinical picture of hyperparathyroidism is most frequently encountered; it may possibly be primary and is unquestionably harmful. The determination of calcium and phosphate content of the serum should be made in all cases of generalized bone disease, not only as a matter of interest but because of their therapeutic indications.

ROE J. MAIER, M.D.

THYROID (THERAPY)

Special Points in the Treatment of Diseases of the Thyroid Gland. C. C. Higgins. Journal-Lancet, March 1, 1930, L, 99.

In connection with the treatment of exophthalmic goiter, the author estimates that of the two thousand or more patients observed yearly more than one-half have hyperthyroidism. During the past two years, X-ray treatment has been used on many of these. The main argument against this treatment is the importance of the time element, during which interval visceral changes may develop. He does not advocate X-ray treatment as the primary form of therapy in many cases.

W. W. WATKINS, M.D.

Roentgen Treatment of Toxic Goiter. E. Hayer and W. Hufschmid. Strahlentherapie, 1930, XXXVI, 477.

Roentgen treatment of toxic goiter has been very satisfactory in the medical clinic of the University of Kiel. Three fields of exposure were used, one each over the left and right lobe of the thyroid and one over the thymic area. Technic: 150 to 180 K.V., 4.0 Al or 0.5 copper; half value layer in copper = 0.3 or 1.15 mm.; initial dose approximately 60 r. If this was tolerated well, 90 to 120 r were given after 14 days, and 150 or 180 r two or three weeks later. In most cases only one field per day was exposed. Of 47 patients who were treated one year previous to this report, 21 are free of symptoms and improved, 7 show no improvement, 6 died, 6 were operated on, and 7 could not be traced. Of 57 patients who were under treatment longer than three months, 10 are free of symptoms, 29 are improved, and 16 are unimproved. One patient died and one did not return for further treatment. Of 19 patients who have been

under treatment less than three months, 15 are improved, 3 not improved, and 1 could not be traced.

The author makes the recommendation that X-ray therapy be given a trial in all cases of toxic goiter, unless alarming symptoms demand immediate operation.

E. A. POHLE, M.D., Ph.D.

Malignant Tumors of the Thyroid Gland. Carrington Williams. Virginia Med. Monthly, July, 1930, LVII, 228.

In treating malignant tumors of the thyroid gland, remember that many of them arise in pre-existing adenomas. All nodular goiters should be removed. When the cervical lymph nodes are involved the condition is usually inoperable, but not always so. Following operation, very thorough treatment by X-ray is advised, regardless of the possibility of hypothyroidism. The inoperable cases may derive considerable relief from radium and X-ray, and should be so treated.

W. W. WATKINS, M.D.

Our Method of X-ray Therapy of Basedow's Disease in Older Women. Anna Jugenburg. Strahlentherapie, 1930, XXXVI, 491.

The author observed five deaths among 160 patients with Basedow's disease whose histories are briefly related. In addition to the usual exposure of the thyroid and thymic region the hypophysis was also irradiated by filtered roentgen rays of short wave length. Technic: 6×8 sq. cm. field, one each over the left and right temporal, one over the occipital, and one over the frontal region, 242 r per field. In one sitting there was only one field given, the next one at from 1 to 2 days' interval.

The author arrives at the conclusion that Basedow's disease in older women takes a more severe course. The disturbance in the endocrine system is caused by changes in the ovaries, thyroid, and hypophysis. In all cases where exposure of the thyroid alone does not lead to improvement the hypophysis is irradiated next. This therapy is also indicated in younger women suffering from Basedow's disease, if a hyperfunction of the hypophysis is probable.

E. A. POHLE, M.D., Ph.D.

TUBERCULOSIS (DIAGNOSIS)

The Diagnosis of Early Ileocecal Tuberculosis: A Preliminary Report, with Special Reference to the Double Contrast Enema. J. Gershon-Cohen. Am. Jour. Roentgenol. and Rad. Ther., October, 1930, XXIV, 367.

This report is intended to set forth the technic and to emphasize the value of the "double contrast colographic" studies of ileocecal tuberculosis. Without special preparation, an opaque mixture, such as is in common use, is first injected into the colon under roentgenoscopic control, paying special attention to spasm and irritability of the colon, particularly on the right side. Mass peristalsis, anastalsis, competency of the ileocecal valve, outline of the colon, ileocecal valve, and terminal ileum, the presence or absence of pain and tenderness over any segment of the colon, the distribution, form, balancing, and the peristaltic changes of the haustra, the mobility of the cecum and ascending colon, and the constancy of irregularities are noted. Roentgenographic examinations are also made and the patient is permitted to evacuate the opaque contents. This is followed by another intermediary roentgenoscopic examination and the distribution of the residual contents noted. Mass peristalsis of a residual column in any colonic segment is looked for at this time. The colon is then slowly inflated with air, using a Pulitzer bag with a ball-valve. The roentgenoscopic examination is then repeated. The author considers this method more valuable in arriving at an earlier and more definite diagnosis. These studies are made with greater dispatch and less annoyance to the patient than when the serial meal method is used. They require fewer exposures than the serial examinations, and when repeated at regular intervals are of precise prognostic value, fur-

nishing an index of therapeutic progress. The article is well illustrated.

J. E. HABBE, M.D.

Tuberculosis of the Knee Joint, Demonstrated by Oxygen Injection into the Joint. B. Ulrichs. Röntgenpraxis, Sept. 15, 1930, II, 817.

The diagnosis of tuberculosis of the knee joint often offers considerable difficulty. The injection of oxygen into the joint occasionally assists in making possible a better diagnosis and may also be of therapeutic value. The author has never encountered any accidents caused by the injection, although he has used it in over two hundred cases. The technic of this procedure is that of Wollenberg. Good roentgenograms and short descriptions of some cases indicate the usefulness of this method in selected cases.

H. W. HEFKE, M.D.

Roentgen Diagnosis of Pulmonary Tuberculosis in Infants and Children. Rolla G. Karshner. California and Western Med., August, 1930, XXXIII, 565.

The roentgenogram will show a pneumonic infiltration of moderate extent which may occur in any lobe. It may be multiple. More frequently the healed remains of the primitive infiltration are detected, though in the greater number of cases it becomes invisible because of its size. Often it is represented only by a strand of fibrous tissue, generally in an upper lobe. Not infrequently the pleura in the region of the site of the initial lesion is involved, leaving a sharp linear shadow extending from the hilum to the periphery. Before pathologic studies revealed the frequency of pulmonary infection in the early months of life, with increasing infection year by year, tuberculosis in infancy was regarded as almost invariably fatal. We now know that even in infancy an advanced tuberculous process may heal.

In the diagnosis of tuberculosis of the intrathoracic lymph nodes, the roentgenogram is indispensable. The diseased lymph nodes, in all their variety of size, shape, and position, are projected as dense shadows extending beyond the mediastinum into the pulmonary field. Lateral views of the chest are essential.

In children, the problem of diagnosis of tuberculous hilum glands becomes more difficult. It can rarely be stated from the roentgenogram whether or not disease of the intrathoracic lymph nodes is the cause of the child's symptoms. There may be no correspondence between the size of the glands and the severity of clinical symptoms. Neither can enlargement of the tuberculous nodes always be distinguished from moderate tumefaction of hyperplastic lymph nodes, particularly in the absence of caseation or calcification.

Hilum tuberculosis is a much more common form of the disease in early adult life, yet but for the roentgenogram it would usually be undiscovered. The process originates at the root of the lung and extends outward a variable distance.

In infants, it consists of a cheesy tuberculosis of the lung root tissues, rapidly progressive, with a bad prognosis. The triangular shadow of ordinary infantile pneumonia has its base at the periphery, whereas in hilum tuberculosis it is at the root. In the author's experience it was nearly always right-sided.

This may be a terminal phenomenon in any type of tuberculosis. In rare instances it is purely pulmonary, the infiltrations not regular in distribution, and there may be caseation or fibrosis. This type ocurs secondary to an older lesion in the lungs and may develop after the age of infancy. The first symptoms frequently follow closely upon measles or whooping-cough. The disease occasionally heals, though it is usually fatal.

F. B. SHELDON, M.D.

Tuberculosis in Children. Henry D. Chadwick. New England Jour. Med., May 29, 1930, CCII, 1044.

The diagnosis of tuberculosis in children depends upon consideration of the history, symptoms, physical signs, tuberculin test, X-ray evidence, and exclusion of other causes for symptoms.

"An X-ray is indispensable in the examination of a child's chest. Without it a positive diagnosis of the childhood type of tuberculo-

sis cannot be made. Furthermore, a physician, however good a clinician he may be, is not justified in excluding tuberculosis without checking his physical examination of the chest with the evidence that only an X-ray film can give."

The two types of lesions to be looked for in the roentgenogram are: (*a*) the parenchymal, which may be nodular or diffuse, and (*b*) the tracheobronchial, which may be seen as masses along the trachea, the main bronchi, or their larger subdivisions. One or the other, or a combination of both, may be present.

W. W. WATKINS, M.D.

Pulmonary and Secondary Intestinal Tuberculosis: A Correlative Study. Eli H. Rubin. Am. Rev. Tuberc., August, 1930, XXII, 184.

The author gives detailed reports on the presence of intestinal and laryngeal tuberculosis found in the course of five hundred autopsies on patients who had died of pulmonary tuberculosis.

Approximately 65 per cent of patients who had died of chronic pulmonary tuberculosis between the ages of 31 and 50 years had intestinal tuberculosis also, and laryngeal tuberculosis was found in 45 per cent. A much larger percentage of intestinal and laryngeal involvement was found in the caseous than in the fibrotic types. From a study of this series, the author found well developed, complete healing in the intestinal involvements, which, to his mind, refutes the idea long held that such a complication bars all chance of recovery.

The article, as a whole, gives valuable data on the subject and teaches the necessity of further examinations than of the chest alone in pulmonary tuberculosis.

S. C. BARROW, M.D.